Uncertainty in Games

Playful Thinking

Jesper Juul, Geoffrey Long, and William Uricchio, editors

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Series Foreword

Many people (we series editors included) find videogames exhilarating, but it can be just as interesting to ponder *why* that is so. What do videogames do? What can they be used for? How do they work? How do they relate to the rest of the world? Why is play both so important and so powerful?

Playful Thinking is a series of short, readable, and argumentative books that share some playfulness and excitement with the games that they are about. Each book in the series is small enough to fit in a backpack or coat pocket, and combines depth with readability for any reader interested in playing more thoughtfully or thinking more playfully. This includes, but is by no means limited to, academics, game makers, and curious players.

So, we are casting our net wide. Each book in our series provides a blend of new insights and interesting arguments with overviews of knowledge from game studies and other areas. You will see this reflected not just in the range of titles in our series, but in the range of authors creating them. Our basic assumption is simple: videogames are such a flourishing medium that any new perspective on them is likely to show us something unseen or forgotten, including those from such "unconventional"

voices as artists, philosophers, or specialists in other industries or fields of study. These books will be bridge-builders, cross-pollinating both areas with new knowledge and new ways of thinking.

At its heart, this is what Playful Thinking is all about: new ways of thinking about games, and new ways of using games to think about the rest of the world.

1 Introduction

Uncertainty is not, in most circumstances, a good thing. We do not wish to be uncertain about whether we can pay our bills, uncertain of the affections of the people who matter to us, uncertain about our health, or uncertain about our job prospects. Businesses are always concerned about the management of risk; they seek ways to reduce uncertainty. At least in the developed world, people pay taxes mainly as a means of reducing uncertainty—the risk of invasion and conquest, the uncertainty of terrorism, the risks created by possible unemployment, by loss of income in old age, and by health crises. They top this off by devoting a portion of their income to insurance, pension plans, and savings, all attempts to reduce uncertainty in their lives.

Yet if the goal is a reduction in uncertainty, the reality is that we live in an uncertain and conditional universe. Even in apparently civilized countries, madmen may come to power and slaughter millions of their own citizens. Apparently sane leaders maintain arsenals capable of destroying whole cities at a blow. Despite the miracles of modern medicine, terrifying diseases can spring out of nowhere and devastate whole populations. Seemingly harmless practices—smoking, applying pesticides, drilling for undersea oil—can turn out to have devastating and

unexpected consequences. We may wind up cooking ourselves in our own industrial waste, or turning the oceans into sewers. For that matter, terrorists could get hold of a nuke, an asteroid impact could erase tetrapodal life from the planet, a nearby star could go supernova and subject us all to killing radiation, nanotechnology could turn us all into gray goo, and Jesus could return, smiting all sinners—and I can assure you that, by the standards of the people who think this last remotely possible, I certainly qualify as a sinner.

The world is in fact filled with terrifying uncertainty, and it is a tribute to the dauntless and objectively insane optimism of the human species that we, most of the time, are fairly cheerful about it.

But the reality is that we are faced with uncertainty throughout our lives—and that much of our effort is devoted to managing and ameliorating that uncertainty. Is it any wonder, then, that we have taken this aspect of our lives, and transformed it culturally, made a series of elaborate constructs that subject us to uncertainty—but in a fictive and nonthreatening way?

I'm talking about games, of course.

In the course of this book, I shall endeavor to persuade you that games require uncertainty to hold our interest, and that the struggle to master uncertainty is central to the appeal of games. I will explore the many sources of uncertainty in games of diverse sorts and come to some conclusions about how to categorize these different sources of uncertainty. Finally, I will suggest ways in which game designers who wish to design with intentionality, that is, to purposefully craft novel game experiences rather than implement a new skin for a well-understood game genre, can use an understanding of game uncertainty in its many forms to improve their designs.

2 Games and Culture

What humans *do* is create culture. Culture is what differentiates humans from other animals.

The most primitive life-forms—amoebas, for example—adapt to their environment almost exclusively through evolution. Only over generations of slow change can new behaviors be added to their repertoire of the possible. In other words, they store information only in the genes.

Somewhat more advanced species—like, say, reptiles—are capable of learning new behaviors; they can store information also in the memory, but have no means of transmitting that information to others.

Most mammals, and some birds, can indeed impart things they've learned to others; birdsong varies by region within a species, kittens need to learn the kill stroke from their mother (or as adults, they won't know what to do with a mouse). Memories can be shared, at least to a degree.

When animals that live in social groups have the ability to learn, you get the beginnings of culture, that is, the transmission of knowledge within a group. Von Schaik[1] describes how one group of orangutans knew to use a stick to get into the flesh of a spiny fruit, while another group living nearby did not have this

knowledge. In general, the great apes and elephants are known to have cultural practices that vary by group, and to transmit information within the group. In an anthropological sense, they have culture—not, obviously, in as elaborate a form as among humans, but culture nonetheless. They have the ability to store information not merely in the genes, or in the memories of individuals, but in the collective knowledge of the society.

While some great apes have been taught rudimentary sign language, humans are largely unique in their ability to speak and, more generally, to use symbols and manipulate abstract concepts (both abilities that are implied by language). Thus, while apes and elephants have culture, humans have culture on steroids, because language allows us to transmit knowledge far more effectively. The invention of writing allows knowledge to be fixed in tangible form and transmitted through generations; the printing press made writing far more available throughout society; and the Internet makes all knowledge quickly and readily available to everyone (with a net connection, at least).

Our ability to create, manipulate, transmit, and understand culture is ultimately what makes us unique on the planet; and it is no surprise that we take *everything* we do and build elaborate cultural constructs about it.

Let us take cuisine as an example. All animals eat. Humans, however, create culture out of eating. Not simply content to ingest fuel to survive, we create rituals, techniques, and places for eating, and imbue the act of eating with cultural significance. We eat to cement family ties, to make business relationships, to explore friendships; we eat in chic Soho restaurants and fast food outlets and greasy spoons and around the family dining table; we braise, roast, stir-fry, and bake; we write and read books that explain how to create particularly tasty food. Only humans

take the simple act of ingesting nutrition and elaborate it in this complicated way. And it isn't just Western civilization that does so—every human culture assigns cultural meaning to food.

Or let us look at story. Language is natural to humans—indeed, language is what sets us apart from the animals. Given the existence of language, it is inevitable that we will want to describe past events to each other. Past events must be described in a way that gives a sense of context and the actors involved—the fundamental building blocks of story. Once we have learned to relate past events, it is inevitable that we will learn to lie about them—relating false past events—because humans are social animals, always striving for the acceptance and approval of others, and true events don't always give us that. Once we have learned to lie, it is a short jump from "lying for personal benefit" to "lying for entertainment value," and once that concept is understood, it's a short step to storytelling. But over the years, storytelling gets elaborated, until we have movies, noir novels, Noh drama, and limericks.

Animals eat; we eat arugula and goat cheese with lardons, toasted walnuts, and Dijon vinaigrette. All animals drink; we have Coca-Cola and the Schramsberg blanc de blanc. Mammals have sex; we have all-day weddings with elaborate ceremonies—and BDSM clubs. Apes will tap out a rhythm; we have the *Eroica* symphony, and *Rock Band*. Animals can see; we have the *Mona Lisa*. Beavers build dams and wasps build nests; we build Paris.

In other words, everything we do by nature, we complexify and reify and elaborate to an extreme degree through our culture—because culture, and the complex civilization it has enabled, is fundamental to our nature.

One of the things we do, of course, is play. Play is fundamental to all mammals; kittens tussle, dogs romp, dolphins swim

about each other in balletic displays. Play, it is said, is one of the ways that young animals learn survival skills—those kittens are hiding and pouncing, key skills for catching prey. But they're learning those skills in a nonthreatening environment; their siblings will not turn and bite viciously, the way an actual rat will. Play is earnest, yet not in earnest; it takes place in a protected space (as do games). Play is something that exists in every species that can learn, and for whom the skills they must learn are important to survival—but not among species whose behavior is dominated by genetics alone. Bugs do not play.

Play in the style of animals exists among young humans, too, of course—climbing and jumping, tussling and running. Even that we elaborate culturally by building playgrounds, by making toys. It isn't long before children *themselves* begin to elaborate their play—to imagine settings, to pretend that toys are characters, to negotiate rules and roles with other children.

The classic example, of course, is *Cops and Robbers*, a form of imaginative play in which two opposing teams have some sort of play fight. "Bang bang, you're dead." "No I'm not!"

Immediately, the need for a rule arises—and immediately, the children will negotiate one, whether implicit or explicit. A typical rule is that if the "shooter" has line of sight to his target, the target is dead, unless the target player can provide a narrative explanation of sufficient appeal for why he didn't die ("I dove for the ground, rolling and rolling and pulling out my gun!") That's an implicit rule, and a fuzzy one, but it's a rule nonetheless (and no fuzzier than the rules for, say, *Charades*, or any number of narrativist RPGs [role-playing games]).

Because they are social beasts, and language users, even very young humans do something that animals do not: they create culture out of play, elaborating an instinctive behavior

in an expressive and meaningful way. They create, in a word, games.

Humanity has created games deep into its prehistory; from physical contests we created sports, from observations of random behavior we created luck games and the casting of lots; from these we created the earliest boardgames. We took the desire to create safe, temporary spaces for playful contests, and constructed elaborate rules for new games, which we imbued with social meaning. From carefree exploration of each other and the environment—the essence of animal play—we ultimately built elaborate cerebral artifacts; there's a direct line, as strange as it may be, between a litter of kittens tussling with each other and two people pondering a *Chess* board. They're both forms of play; but the former is unbounded, unscripted, and *simple* play, while the latter is the product of thousands of years of cultural refinement and elaboration. And playing *Chess* has social meaning, too; to say "I play *Chess*" is to make a claim to be regarded as a thinker, an intellectual of a sort, and perhaps one who prizes the pleasures of the mind over the pleasures of the body.

In a sense, "game" is merely the term we apply to a particular kind of play: play that has gone beyond the simple, and has been complexified and refined by human culture. Just as novels and movies are artistic forms that derive from the human impulse to tell stories, and music is the artistic form that derives from our pleasure in sound, so "the game" is the artistic form that derives from our impulse to play.

3 Uncertainty

Uncertainty, in fact, is a primary characteristic of all sorts of play, and not of games alone; if you think like a programmer, you might say that Game is a subclass of Play, and inherits from Play the characteristic of Uncertainty.

In *Les jeux et les hommes,*[1] the sociologist Roger Caillois says: "Play is . . . uncertain activity. Doubt must remain until the end, and hinges upon the denouement. . . . Every game of skill, by definition, involves the risk for the player of missing his stroke and the threat of defeat, without which the game would no longer be pleasing. In fact, the game is no longer pleasing to one who, because he is too well trained or skilful, wins effortlessly and infallibly."

Caillois calls simple play, unencumbered by rules, *paidia*, and rules-bound play *ludus*. As I prefer to eschew obscurantism, I believe "simple play" and "game" will suffice. Even in simple play, uncertainty is necessary; if, for instance, your older brother always beats you in a footrace, you will quickly lose interest in playing with him. If your friend Jessica always wants to be the princess and insists that you must belong to the supporting cast—prince, ogre, ugly stepsister—and particularly if she never permits a reversal in the story whereby her premier status is

overturned—you will want to find another way to play. Simple play is, in the ideal, joyful and inventive; if it becomes predictable, both the inventiveness and the joy are lost.

The need for uncertainty is, if anything, even truer in games; if our expectation is of predictability, we are unlikely to enjoy the game.

Consider, for example, the game of *Tic-Tac-Toe* (or *Noughts and Crosses*, as the Brits call it). Unless you have lived in a Skinner box from an early age, you know that the outcome of the game is utterly certain. Whoever goes first will take the central square, because occupying it is advantageous, and unless one player is naïve or stupid, players will prevent each other from winning by blocking any attempt to get three in a row. It is a solved game, and a trivial one, and no one beyond a certain age can play it with enjoyment, because no uncertainty about the game's path exists.

And yet the game survives, is taught to each new generation, and is played, by children, with every evidence of enjoyment. The explanation for this is simple: the naïve player has not yet learned, or figured out, that the game has an optimal strategy. To the child, the outcome seems uncertain—as it is, since two players, both playing without an understanding of the game's strategy, produce an uncertain outcome. Thus, a naïve player may experience fiero in winning *Tic-Tac-Toe*, or the fleeting sadness of loss upon losing. In other words, *Tic-Tac-Toe* can be experienced as enjoyable only by naïve players, because only for them is its outcome uncertain.

Caillois's discussion of uncertainty, however, implies that the *outcome* of a game must be uncertain for it to be enjoyable; in this, he is incorrect. The outcome of *Space Invaders* (Nishikado, 1978) for example, is certain: The player will lose. Sooner or

later, the player will be overwhelmed by the serried ranks of invading aliens, and the game will end in a loss. *Space Invaders*, like many of the early arcade games, has, curiously, no win state. But "win or lose" is, after all, merely a binary; *Space Invaders* has a numerical score, which increases with each alien slain, and with no theoretical upper bound to the score. Moreover, a player who achieves one of the top scores on the machine with which he engages may enter his name (or a few characters, anyway), with his score thereafter recorded for everyone to see for all time to come—or until the machine is reset, of course. The goal of *Space Invaders* is not to "win," for you cannot, but to achieve a high score—perhaps bettering your own previous score, perhaps achieving a place on the high score list, perhaps outdoing a friend, perhaps achieving the top slot on the list. The uncertainty of the game lies not in its ultimate outcome, but in the final score.

Based on this, you could argue that Caillois was wrong only in failing to see that the outcome of a game can be more than a binary "win" or "loss" state—that it can be expressed numerically, with a wider range of possibilities. But actually, there's a deeper problem here; not all games have outcomes.

This is a problem not only for Caillois, but also for Salen and Zimmerman, authors of the landmark game studies volume, *Rules of Play*. They define a game as follows: "A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome."[2]

There's a fair bit to unpack there, and I don't propose to critique the definition word by word; I'm concerned only with "quantifiable outcome," here. Certainly, both win/loss and a score are "quantifiable outcomes"; but what is the "quantifiable outcome" of a game of *Dungeons & Dragons* (Gygax and Arneson,

1974)? *Dungeons & Dragons* has numbers, of course: experience points, player levels, hit points, and so on. It quantifies a great deal. And while the game offers players the implicit goal of improving their character and its capabilities by earning experience points and thereby increasing in level, this is not a competition among the players, who are instead expected to cooperate rather than oppose one another. Nobody "wins." A single session of *Dungeons & Dragons* may come to an outcome—a logical break point in the story is reached, or the players get tired and go home—but unless the gamemaster chooses, for his own reasons, to impose some arbitrary stopping point to the game, it can go on, in principle, forever. Indeed, some games have gone on for decades, with a degree of continuity in terms of the players, their characters, and the setting.

In short, a game of *Dungeons & Dragons* can end, and, if tied to a story, there may be some narrative outcome; and much of the game is quantified. But no outcome is necessary, and quantification is irrelevant to the outcome, if any; outcomes are narrative in nature, not imposed by the game system.

Dungeons & Dragons is far from unique in this regard; *World of Warcraft* (Metzen, Pardo, and Adham, 2004) is the same. There are lots of numbers, and characters work to increase them, but there is no leaderboard, no end of game, no wins or losses or competitive ranking. If *World of Warcraft* ever has an "outcome," it will be because Blizzard tires of the game, or its player base erodes over time to render it unprofitable, and someday the operators close it down. It has no outcome in any meaningful sense.

World of Warcraft is, of course, ultimately derivative of *Dungeons & Dragons*; but the same characteristic pervades today's most popular and commercially successful game form, the

so-called social game. *CityVille* (uncredited, 2010) and *Mobsters* (uncredited, 2008) have no "outcomes"; like *Dungeons & Dragons* and *World of Warcraft*, they are "games neverending."

Certainly these games contain uncertainty; if they were entirely predictable, people would long ago have stopped playing them. The uncertainty is not in the *outcome*, however, because there *is* no outcome. The uncertainty is in the path the game follows, in how players manage problems, in the surprises they hold.

Caillois is correct, therefore, in his assertion that uncertainty is a key element of play, and by extension all games, and incorrect only in his suggestion that uncertainty of *outcome* is essential; uncertainty can be found almost anywhere, as we will see when we begin to analyze individual games.

What Caillois and I call uncertainty, the cultural anthropologist Thomas Malaby[3] calls "contingency." Interestingly, he claims that the main reason games are compelling is that our experience of the real world is "contingent"—the world is unpredictable—and that grappling with the same kind of unpredictability in the more constrained context of the game appeals to our fundamental nature. In other words, he's making essentially the same claim I made at the beginning of this book; that part of the reason games appeal is because they allow us to explore uncertainty, a fundamental problem we grapple with every day, in a nonthreatening way.

I don't have any greater use for the term "contingency" than I do for Caillois's "paidia" and "ludus," however; it obscures rather than reveals. Contingency merely implies that one thing depends on another. The statement "If A, then B" is contingent; the truth of B is contingent on the truth, or falsity, of A. But it

is also perfectly certain; if we know the state of A, we know with certainty the state of B.

Indeed, the distinction between contingency and uncertainty is illustrative of the distinction between games and puzzles. Puzzles are full of contingencies; the solution to one clue in the crossword is contingent on the letters revealed by a cross. The solution to a logic puzzle is contingent on the clues provided. The solution to Sudoku is contingent on the arrangement of the prefilled squares. The only uncertainty involved is in the solver's ability to sort through the contingencies; or to put it another way, a puzzle is static. It is not a state machine. It does not respond to input. It is not uncertain; and it is not interactive.

All games are interactive—nondigital games just as much as digital ones. To be "interactive" means that there are two (or more) parties to a phenomenon, and the actions of one meaningfully affects the state of the other, and vice versa. Conversation is a form of interaction. So, for that matter, is using a light switch; the user's flick causes a change in the state machine that is your house's electrical system, which produces a stream of electricity to a light bulb, which casts illumination on you.

Consider the game of *Chess* as an interaction between two players. The game itself is a state machine whose state is recorded in the positions of the pieces on the board. The players impose a culturally agreed-upon set of algorithms to determine how and under what circumstances the state of the game may be modified, which involves each player responding to the actions of the other sequentially, until a particular state, known as "checkmate," is reached. The fact that the gamestate is represented in physical form, and that the algorithms used to modify its state

are applied by live people rather than a computing device, does not alter the fact that, at its core, the game is interactive.

What would a “noninteractive game” be like? Games by nature either involve multiple players, who interact with each other in some fashion—or a single player attempting to deal with a system that poses some kind of challenge, whether that be ‘beating’ a level-based videogame or applying the rules of *Klondike Solitaire* to move all cards legally from the tableau to piles sorted by value and suit. In short, even soloplay games are “interactive,” albeit in this case the interaction is between a single player and some algorithmic system that responds to the player’s actions.

If you took the pieces of a *Chess* set and nailed them to the board, you might have a “noninteractive game,” in some sense, but it would no longer be playable.

So all games are interactive. Of course, many other things are interactive as well—the light switch we alluded to, the word processor on which I am composing this book, Google, eBay, and the American political system, for instance. None of these things are games.

To say *why* these things are not games would require us to define “the game”; while trying to do so is an enjoyable pastime in its own right, one in which I have indulged elsewhere, it could produce a book in its own right, and not this one. But it’s worth noting one major distinction between games and just about every other form of interaction; games thrive on uncertainty, whereas other interactive entities do their best to minimize it.

Indeed, in the realm of interactive applications, whole disciplines—information architecture, human–computer interaction (HCI), and user-centered design (UCD)—have been invented

precisely to help people create *less* uncertain interactions. If we are shopping online or operating an air conditioner, or for that matter electing a congressman, uncertainty and challenge are the *last* things we want. Rather, we prefer simplicity, surety, and consistency.

You often hear people saying that they want to make their applications or websites more "gamelike." They do not, in fact, mean it. I could make Microsoft Word more gamelike; let us say that in order to make text boldface consistently, I need to be a level 12 Word user. Before I get to that level, every time I try to boldface something, the application does a check, rolling against my level, in effect. If I fail the check, it applies a random font effect instead of boldface. This would not be "more entertaining"; it would be infuriating.

In short, in designing most interactive products, the elimination of uncertainty is desirable. In designing games, a degree of uncertainty is essential. This is why people who try to apply, say, the theories of HCI expert Jakob Nielsen to games often err; interface clarity may still be desirable, but eliminating challenge and uncertainty is not. Games are *supposed* to be, in some sense, "hard to use," or at least, nontrivial to win.

4 Analyzing Games

I've said that uncertainty is a key element of games, and that uncertainty can be found in games in many ways. To gain a better understanding of how games exploit uncertainty, and how they generate it, let us examine a series of games in search of their sources of uncertainty. Once we have done so, we will perhaps be better equipped to categorize the types of uncertainty in games, to identify uncertainty in new games, and perhaps even to understand how and why some games succeed and others fail.[1]

Super Mario Bros.

Super Mario Bros. (Miyamoto, 1985) seems a good place to start, both because of its importance to the field and its huge influence on a whole generation of game designers—and because, at first glance, you might be hard put to find any source of uncertainty in the game.

When you begin the game, you see a small figure—Mario—standing under a sky. Attempting to move to the left does nothing. Moving to the right scrolls the world. There is no uncertainty about where to go; indeed, throughout the game, there is none.

You need to go right. You may at times move left to avoid enemies or the like, but completing each level requires rightward motion, and any leftward motion is purely tactical.

You quickly learn that the goal of the game is to avoid dying, and to complete each level within a time limit. The time limit is set by the game and is invariant. Completing a level requires you to face three kinds of challenges: those of navigation, enemies, and traps.

Navigational challenges are all ultimately challenges of timing; you must time a leap to jump over obstacles, or move onto or off of moving platforms at appropriate moments, and so on. All of these navigational challenges are entirely nonrandom, and simple in conception—perhaps less simple in execution. As a player, you may face some *initial* uncertainty as to what you will encounter and what you need to do to surmount these challenges—that is, you are not yet familiar with the level layout—but you quickly lose that uncertainty. Level layouts are invariant; there is no randomness or other algorithmic generation in the challenges you face. They are the same every time. They are uncertain only when first encountered.

Similarly, each type of enemy obeys simple, easily recognizable patterns of behavior. Different enemies have different behaviors—some simply move to the left; some move toward you, whichever way that requires them to move; some shoot at you—but all enemies of a particular class behave in identical ways, and you quickly learn their patterns. The specific tasks you need to accomplish to evade or defeat each enemy are uncertain only at first, but you quickly learn the drill. Once you have done so, there is no uncertainty about what enemies will do.

Nor is there any uncertainty about the effect of enemies upon you; enemies kill you. There is no combat system per se,

although you can defeat many enemies by bouncing atop them. No dice are rolled, no complex algorithms applied to determine the outcome of contact with enemies: You die.

Similarly, all traps of the same type appear the same, all behave according to the same rules for traps of their type, and all can be overcome via simple rules. Traps must be avoided or evaded; otherwise, they kill you. There is no uncertainty to them.

The controls of the game are equally certain; indeed, *Super Mario Bros*. is notable for the crispness, responsiveness, and predictability of its controls. Motion is at an invariant speed—or rather, two invariant speeds: holding the B button while using the D-pad moves you faster, but at an invariant faster speed. Similarly, jumps are of predictable heights and durations, with a regular jump and a "higher" jump triggered by holding the A button. There is no randomness, no uncertainty, no variability to the controls; they are simple and intuitive.

There is almost no uncertainty as to path, either. While some levels have "secret areas," and some allow the level to be traversed in two or more ways, the branch-points at which the player may choose one path over another are few. And even when these exist, each path is always the same, every game you play.

In short, almost all of the ways that other games create uncertainty are completely or almost completely lacking in *Super Mario Bros*. The player's path through the game, with minor variations, is determined. The outcome is equally determined—with perseverance, the player will win. Moment-to-moment gameplay will vary relatively little between sessions of play.

Yet it cannot be denied that *Super Mario Bros.* is a superb game, practically the epitome of excellence in sidescroller design. Patrick Curry has gone so far as to declare: "Everything I know

about game design I learned from Super Mario Bros."[2]—a statement that is remarkable, given how much an outlier this game, and sidescrollers in general, are in the universe of all games.

Playing *Super Mario Bros.*, unless you are a sort of sidescrolling Zen master, is, despite its somewhat lockstep nature, still a tense experience. An enemy is approaching, and you must jump at *just the right moment* to land atop and dispatch him. A leap to a moving platform must be timed *just so*. Enemy missiles must be ducked at exactly the right time. Success at *Super Mario Bros.* depends on hard-won interface mastery and a sense of the rhythm of the game—and combining those hard-won skills to master challenges of increasing density and complexity as the game goes on.

In other words, in *Super Mario Bros.*, the uncertainty is in *your performance*—in your ability to master the skills of hand-eye coordination demanded by the game and apply them to overcome its challenges. You can—and typically do—fail many, many times before "beating" the game. Mastering, and overcoming, the uncertainty posed by your uncertain skills, and your uncertain ability to maintain concentration and focus, is the heart of the appeal of the game.

Super Mario Bros. is practically the Platonic ideal of what game designers call a "player-skill" (as opposed to "character-skill") game. Luck is not a factor. Strategic thinking is not relevant. Puzzle solving is rarely germane. Success is virtually 100 percent dependent on your mastery of the controls, and your ability to respond to the situation unfolding on your screen with accuracy and alacrity. *Super Mario Bros.* has the same kind of elegance, simplicity, and purity we see in games like *Chess* or *Soccer* or *Diplomacy*; it is a game stripped down to a single set of challenges and carefully honed to the essential minimum. *Super*

Mario Bros. is the example par excellence of the game of performative uncertainty.

The Curse of Monkey Island

The Curse of Monkey Island (Ackley and Ahern, 1997) is one of the finest graphic adventures ever published. The third in a series featuring the protagonist Guybrush Threepwood, all set in a somewhat romanticized and fantastical Caribbean of the pirate era, its gameplay is centered on inventory puzzles.

The Curse of Monkey Island was published once CD-ROMs were widely established and PC games were capable of supplying extensive voice acting, music, and animation—but before 3D graphics became mandatory for retail-release titles. 3D is problematic for graphic adventures, which require you to identify and interact with on-screen objects; in a 3D environment, objects can readily be obscured or difficult to find given the problems of camera control in a 3D space. Thus, *Curse of Monkey Island* was published at the moment when graphic adventures were at their most appealing and before their precipitous decline.

As with adventure games of both the text and graphic variety, excellence in dialogue, language, and storytelling are central to the appeal of the game, but these are, of course, matters largely extraneous to gameplay per se. Like other adventure games, *The Curse of Monkey Island* is quite linear; you begin at a single location and must solve a set of problems to unlock others. At some times, you have access to puzzles at several locations and may solve them in variable order, but the approach is that of "beads on a string": within a bead, you have some choice of where to go and what to do, but once you have progressed to the next bead, opportunities previously available are no longer around. In

short, while there may at certain points be uncertainty or choice in terms of navigation, this is extremely limited, and more illusion than reality.

Advancing in *The Curse of Monkey Island* involves three kinds of activities: minigames, “insult sword fighting,” and inventory puzzles. Minigames are typically arcade-style games dependent on timing. Insult sword fighting is a system whereby you engage in a “sword fight” with another character, but success depends on countering any line of dialogue spoken by your opponent with a witty retort (e.g., “You fight like a dairy farmer,” countered by “How appropriate! You fight like a cow!”). You “learn” the appropriate responses from low-level battles in order to triumph in higher-level ones. There is actually no uncertainty initially, because until you learn the correct retort, the menu does not offer it to you. Later on, the only uncertainty is in whether or not you can remember (or deduce) the correct response from those offered—a form of the game *Memory*.

As with most adventures, the main challenges are in the form of inventory puzzles. For example, at one point, you are swallowed by a snake. The snake has previously swallowed many items, which you may grab. Among them is pancake syrup. An item you will have previously picked up is an ipecac flower. By combining the ipecac flower with the pancake syrup, you create syrup of ipecac. Using it on the snake’s head causes the snake to vomit you out.

Inventory problems, then, involve several features: identifying in-game objects that you can add to your inventory; identifying which can be combined with others to produce items of use; deducing a semi-logical solution to the puzzle you are posed; and, quite often, having some knowledge exterior to the game that elucidates the puzzle (syrup of ipecac is used to induce

vomiting, and is often kept in the medicine cabinets of the parents of young children, in the event that the children will consume something poisonous, for which induced vomiting is an appropriate treatment).

Invariably, the number of inventory items is finite, and the potential combinations are finite, so that puzzles can often be solved through brute force (try everything with everything); but the fiero moment in games of this kind is when you figure out a solution and slap your head at the thought that you should have deduced it long ago.

Some adventure games fail because the solutions to their puzzles are obscure or illogical, or because inventory items are difficult to find (the "hunt the pixel" problem—something that the "hidden object" genre of puzzle games actually makes central to gameplay). But when an adventure game is well designed, the puzzles dovetail with the story, they are challenging but not impossible, and their solutions seem obvious and plausible, at least in retrospect.

In *Curse of Monkey Island* and other adventure games, there are no random elements, no complexity of system that makes achieving victory a challenge; there's no "player skill," no need to master physical skills to overcome obstacles. The challenge is entirely mental—solving the puzzles—and the uncertainty lies wholly in your uncertain ability to do so.

Crawford, in *The Art of Computer Game Design*,[3] questions whether adventure games are games at all; he holds interaction to be central to games, and static puzzles such as Sudoku or the crossword are not state machines. That is, they do not respond to player actions; they are wholly static. They have fixed solutions, but are not "interactive" in any meaningful sense. He would, by extension, categorize all puzzle-based games in the

same fashion: as lacking in true interaction, static, and therefore puzzles, not games. To my mind, this is a stretch; while the solutions to *The Curse of Monkey Island*'s puzzles are invariant, the application as a whole is itself a state machine, with the options available to the player, the areas of the world open to exploration, and the position along the story arc all a function of interaction between the game and the player. It may not be as deeply interactive as *Go* or *Quake* (American McGee, Sandy Petersen, et al., 1996) but it is interactive enough to qualify as a "game," and indeed adventure games are conventionally taken as such.

Curse of Monkey Island is one example of a game for which uncertainty lies in the challenge of puzzle solving, but it—and indeed, adventure games as a whole—are far from the only sort of game that depends on this. Puzzles are the source of uncertainty in games as diverse as *Portal* (uncredited, 2008), *Lemmings* (Jones, 1991), and *Deadly Rooms of Death* (Hermansen, 2002)—games that rely on very different styles of puzzle solving from *Monkey Island*, but each of which offer one or a handful of possible solutions to a series of puzzles, with the tools necessary to solve those puzzles provided to the players, and with the solutions sometimes requiring torturous cogitation and experimentation.

If each puzzle has a single (or a handful of) solution(s), where is the uncertainty? It lies, as in *Super Mario Bros.*, in the player's performance: in this case, not in the performance of physical tasks but of mental ones. Yes, if the player is to advance, he must certainly solve the puzzle; but presented with a new and daunting one, he has some uncertainty about his ability to surmount the challenge. If the puzzle were trivial and easily solvable, if he were in no uncertainty, the game would not hold his interest. For many players it is, to be sure, a source of comfort to know

that, in the vastness of the Internet, there is undoubtedly somewhere a walkthrough for even the most obscure of games, and that should they utterly fail to solve a puzzle, they can still find the means to solve it; but the challenge, and the uncertainty, still lies in their ability to do so without aid.

This is perhaps a *kind* of performative uncertainty, but I prefer to reserve the term "performative uncertainty" for games that pose challenges relating to physical rather than mental performance. For this kind of challenge, I favor the term "solver's uncertainty." In the world of crossword, logic, and other nongame puzzles, those who enjoy solving puzzles are called "solvers," and those who create puzzles are called "constructors." Or to put it another way, with games we talk of players and designers; with puzzles, we talk of solvers and constructors. Thus, "solver's uncertainty" seems an appropriate way to describe the uncertainty caused by the challenge of puzzles in a game.

I feel impelled at this point to embark on a tangent that has nothing to do with the central argument of this book, but that I feel is important and meaningful. Many students (and designers) of games are fans of the work of Csikszentmihalyi,[4] and feel that games ideally induce in player a sense of "flow," as Csikszentmihalyi defines it: an almost ecstatic feeling of action, reaction, and mastery in which time is lost and a feeling of creative impulse suffuses the person in question. Much time and effort is spent in trying to create games that induce a "flow state." I would suggest that while this may be desirable for some games, it is far from desirable for all—and that many games benefit precisely from *jarring* the player *out* of any sense of flow. Puzzle games are one example. Upon completing one puzzle and encountering the next, a player of this sort of game is not likely to feel "I am in the zone, I am the master of this, I react and do the next thing

with preternatural ease"—rather, he is likely to think "Holy crap, what do I do now?"

That is, he is immediately jarred *out* of anything like a flow state and forced to grapple with new problems, to *think* about what he must do next.

I would suggest that rather than striving always to sustain flow, a designer ought to, from time to time, purposefully *break* flow—for his or her own artistic purposes, of course.

FPS Deathmatch Play

Conventionally, we view the first-person shooter (FPS) as a single genre, but gameplay is quite different in multiplayer mode than in soloplay mode. That is, both versions of the game may rely on the same set of controls, and on the same technology to display the gameworld; both may rely on a first-person view and on ranged combat as the player's main tool for overcoming challenges; but the actual concerns of the player, and his goals, are greatly different in the two gameplay modes.

In a soloplay FPS, you must traverse a series of levels, facing a sequence of monsters, traps, and physical obstacles within each level. In other words, the gameplay is quite similar to that of a conventional platformer; winning means traversing all the levels. The main difference is that instead of jumping, mostly you shoot things. You might go so far as to say that *Doom* (Green, Petersen, and Romero, 1993) is the same game as *Super Mario Bros.*—obviously, a vast oversimplification, but a core truth is there.

In deathmatch mode, however, you play within a single, defined physical space, not a linear sequence of levels. Other players also exist in the space; your goal is to shoot them, and

vice versa. Death is rapid and instantaneous (none of the slow reduction in hit points typical of RPGs, though it may take several shots to kill you), but the dead quickly respawn. Typically, the game lasts until one player achieves a certain number of kills, but regardless of victory condition, deathmatch play lasts for only a few minutes.

Games generally offer a wide variety of arenas, and since FPS games are often easily moddable, many fan levels are available as well. A "level" consists not merely of a certain architectural geography, but also the placement of weapons, ammunition, health packs, and similar items within the level, which respawn at some time after being picked up. This placement, along with the architecture of the level itself, creates the strategy of the game: certain locations give good sightlines, or are most defensible; players come to learn where resources are located, and they compete to gain them and deny them, at least temporarily, to enemies.

While a game may support many arenas, there is little or no uncertainty in the design of the arena itself. That is, it may take a few play sessions for a player to get accustomed to a new arena, but players do not view arena novelty as a draw; on the contrary, they are drawn back to play in the same familiar arenas many times over. The reason for this is readily understandable; this is a game of skill, and players wish to feel that they win or lose on the basis of skill, not because of factors they cannot control—such as unfamiliarity with the level's layout. In other words, in practice, uncertainty does not lie in level design. Where then does it lie?

Not in randomness, though unbeknownst to most FPS players, their games do contain a small random factor: FPS weapon damage is typically random within a set range, an element originally introduced with *Doom*, the ur-game of the genre, by John

Romero, who specifically wanted players to be less than 100 percent sure of success with each shot.[5] But the level of uncertainty this causes is slight; it rarely alters the number of hits required to dispatch an opponent and is rarely perceptible to the players.

Clearly, there is a level of performative uncertainty: aiming precisely and timing a shot is difficult, particularly given moving and unpredictable targets. There are problems involved in obtaining sufficient ammunition and access to the best guns and in taking advantage of cover and lines of fire. And finally, there are the tricks of the trade, techniques such as the bunny hop (repeatedly jumping in order to present a more difficult target to opponents) and the rocket jump (setting off an explosive underneath yourself in order to propel yourself higher than permitted by a normal jump), which if properly performed can provide a tactical advantage.

In other words, deathmatch FPS games are very much games of player skill, so much so that online play is often a humiliating experience for new players, who will be repeatedly slagged by more experienced ones until they develop competitive chops. This is, in fact, one of the major design flaws inherent in the genre, which some games attempt to ameliorate with systems to match players by skill.

But there's an aspect to deathmatch play that we do not find in games like *Super Mario Bros.*: opposition is provided not by characteristics of the application itself—programmed enemies, traps, and obstacles—but by live players. The "performative uncertainty" involved in hitting a target is partly based on the uncertain skills of the shooter but also on the unpredictable actions of the target. That is, even with perfect skill mastery, a player may find himself outwitted by an opponent; and you are at least as likely to miss a shot because your target suddenly takes

off in an unexpected direction as because your aim is poor. This is in stark contrast to the enemies of *Super Mario Bros.*, which always appear at the same locations in a level and always behave in predictable fashion.

The simple fact is that people are smarter than machines; most computer-controlled opponents are highly predictable. The industry uses the term "artificial intelligence" (AI) with gay abandon, but even "artificial stupidity" would be a stretch; the algorithms used are rarely complex and constitute nothing a genuine AI researcher would deem remotely interesting. Actual players are always far more unpredictable, tricky, dangerous, and interesting than artificial opposition.

In short, deathmatch FPS games are very much games of player skill, and thus of performative uncertainty; but there is another major source of uncertainty in games of this type—player unpredictability.

In a way, that should be obvious; any game with more than one player involves some uncertainty about what that player will do. But in actuality, some multiplayer games have relatively low levels of player uncertainty—certainly true of, say, *Tic-Tac-Toe*, at least with sophisticated players, since strategies then are predictable. *Monopoly*, which we'll discuss later, is another example of a multiplayer game with low levels of player unpredictability.

Rock/Paper/Scissors

Rock/Paper/Scissors (*R/P/S*) is, of course, a classic folk game, played by two, with trinary simultaneous moves and a rotational victory vector (Rock beats Scissors which beats Paper which beats Rock).

At first glance, it appears almost as brain-dead a game as *Tic-Tac-Toe*. A four-year-old might think there's some strategy to it, but isn't it basically random?

Indeed, people often turn to *Rock/Paper/Scissors* as a way of making random, arbitrary decisions—combat resolution in *Mind's Eye Theatre* (uncredited, 2005) or choosing who'll buy the first round of drinks, say. Yet there is no quantum-uncertainty collapse, no tumble of a die, no random number generator here; both players make a choice. Surely this is wholly *non*random?

All right, nonrandom it is, but perhaps it's arbitrary? There's no predictable or even statistically calculable way of figuring out what an opponent will do next, so that one choice is as good as another, and outcomes will be distributed randomly over time—one-third in victory for one player, one-third to the opponent, one-third in a tie. Yes?

Players quickly learn that this is a guessing game and that your goal is to build a mental model of your opponent, to try to predict his actions. Yet a naïve player, once having realized this, will often conclude that the game is still arbitrary; you get into a sort of infinite loop. If he thinks such-and-so, then I should do this-and-that; but, on the other hand, if he can predict that I will reason thusly, he will instead do the-other-thing, so my response should be something else; but if we go for a third loop—assuming he can reason through the two loops I just did—then . . . and so on, ad infinitum. So it is back to being a purely arbitrary game. No?

No.

The reason *Rock/Paper/Scissors* is not a purely arbitrary game, and the reason that an excellent player will win more often than chance would predict, is that human psychology is *not* random,

and some behaviors are—not necessarily predictable, but likely to occur more often than chance would dictate.

One heuristic of experienced *RPS* players is "Losers lead with Rock." This is demonstrably true; naïve players will lead with Rock more often than one-third of the time. Your hand begins in the form of a rock, and it is easiest to keep it that way. The name of the game begins with "Rock," and if you are mentally sorting through the options, it is the first one that will occur to you. And the word "rock" itself has connotations of strength and immovability. These factors lead players to choose Rock on their first go more often than chance would dictate. An experienced player can take advantage of this. Against a player you know to be naïve, you play Paper.

Similarly, players rarely choose the same symbol three times in a row, and almost never four times; it *feels* wrong to human psychology. An extended streak feels nonrandom and unlikely, even though in a purely random game, each new throw is stochastic, not dependent on the outcomes of previous throws. Thus in a truly random game, no matter how many times "Paper" has come up in a row before, there is a 1 in 3 chance of it coming up again. Given the nature of human psychology, if Paper has come up twice, there is a far less than a 1 in 3 chance that the player will choose it again.

Even players who know this have to consciously try to overcome their bias against streaks—*particularly* if they lose with one gesture on the previous round. If you have played Paper twice in a row, and lost the last time you played, the human instinct is to try something different, and thus players will at that point choose Paper far less than one-third of the time.

In short, a player who has studied the game will unquestionably win more than chance would dictate against a naïve player,

because he understands how human psychology is likely to affect the choices of his opponent. Of course, two players who both understand these factors are on a more even plane; but even here, there is the factor of human readability. It is hard to maintain a perfect “poker face,” and some are better at it than others. Some are better at noticing subtle cues in the expressions or body language of others. These skills are not always sufficient to *ensure* triumph, but they do produce a bias in favor of those more observant—and more socially adept at reading others.

In other words, at first glance *Rock/Paper/Scissors* appears to be a guessing game, with victory going to the player who can outguess his opponent; at second glance, it appears to be purely arbitrary; and at third glance, the original supposition is justified. It *is*, in fact, a guessing game with victory going to the player who can outguess his opponent, but there are strategies to “outguessing.”

Where is the uncertainty in *Rock/Paper/Scissors*? That should be obvious. It is in the unpredictability of opposing players. In fact, that is *all there is* in *Rock/Paper/Scissors*; an FPS played in deathmatch mode may rely to some degree on player unpredictability, but it also relies on player performance. *Rock/Paper/Scissors* is a game of player unpredictability in its purest form, for this single factor is the sole determinant of the game’s uncertainty, its raison d’être, and its cultural continuance.

Diplomacy

Diplomacy (Calhammer, 1959) is a seven-player boardgame that ostensibly represents military conflict in Europe during the early twentieth century, but in fact is an abstract strategy game with a diplomatic/military theme. The board is of Europe, Asia Minor,

and part of the Maghreb, divided into provinces. The borders are those of 1914 (though the first turn is called “Spring, 1901”), and the players represent the European great powers of the time: Austria, England, France, Germany, Italy, Russia, and Turkey. *Diplomacy* is both a beautifully designed game, with clear subtext and enormous polish and a historically important one: it is the first truly “diplomatic” game, by which I mean one in which negotiation and alliances are of vital importance during play.

About one-half of the provinces are “supply center” provinces; each of the players begins with three (four for Russia), and all of the nonplayer countries (Sweden, Spain, and so on) are supply centers as well. Each center can support one unit, either an army or a fleet, and a province may be occupied by only one unit at a time. After two moves (“Spring” and “Fall”), players add up the number of supply center provinces they now control, and either build or remove units so that they have as many in play as the number of such provinces they own, with new units built only in home supply center provinces.

Diplomacy is a simultaneous movement game; players write their orders secretly, and all are revealed at the same time, with the results then adjudicated. The key to the game (the “core mechanic” in Salen and Zimmerman’s terminology[6]) is the “support order.” Each unit may move only one province, in terms of distance; a unit holding still in its province prevents another unit from entering that province, and two units attempting to enter the same province “bounce.” However, a unit may hold in place and “support” a move into an adjacent province, giving that move the power of 2, sufficient to dislodge an unsupported unit or to occupy the province in the face of an unsupported opponent attempting to enter it. One key element: you can support the moves of other players.

Because all the players are of roughly equal power,[7] no player can reasonably expect to win the game alone. To overcome another power, you need an ally. And because units may support moves by other players, alliances are effective.

However, the simultaneous movement nature of the game has another effect: it encourages backstabbing. You can never be certain that, on the next move, your ally will do as he has promised. In addition, the winner of the game is the player who possesses half the supply centers on the board—and if your alliance is successful, it is likely that at some point your ally will become your closest competitor. Winning not only requires you to form alliances—it also, more often than not, requires you to backstab your ally, at just the right time.

The subtext of *Diplomacy* is *realpolitik*—or more specifically, Lord Palmerston's rubric that nations have no permanent friends and no permanent enemies, only permanent interests. As such, it is an amazingly pointed, cynical, and even fascinating game—fascinating, too, for its demonstration that games, even ones relatively simple in terms of their rules, can hold ethical lessons.

The rules of *Diplomacy* are completely deterministic: there is no randomness in its system of combat resolution. It is a game of perfect information: everything on the board is visible at all times to all players. In other words, there is *no* uncertainty in *Diplomacy—except* that you never know what moves the other players are writing down, whether you can rely on the assurances of the others, whether your alliance is strong or others are weak.

While there is a strategic element to the game—planning moves takes thought, and there's a small literature devoted to the strategy of opening moves and the formation of stalemate lines—the primary determinant of victory is not mastery of strategy, but the ability to persuade and bamboozle. If you are

a master of *Diplomacy*, you can unquestionably have a career in sales.

In other words, as with *Rock/Paper/Scissors*—and for reasons evoked by very different mechanics—the uncertainty in *Diplomacy* derives almost entirely from the unpredictability of the other players, and the player who best manages that unpredictability will be its winner. Hidden information, in that you do not know the moves of others until you have committed to your own, also contributes to the game's uncertainty.

Monopoly

From our discussion of *Diplomacy* and *Rock/Paper/Scissors*, you might conclude that player unpredictability plays an important role in *every* multiplayer game. In fact, this is not always the case.

Monopoly (Darrow, 1935) is a multiplayer game with a real-estate development theme that, despite high complexity (by mass-market standards), has become a perennial.

It's a familiar enough game that I will not recap its essential gameplay.

In *Monopoly*, there is no direct way for players to injure one another. It is true that when one player lands on another's property, he must pay money to the property owner, which is an injury since the game is won by bankrupting your opponents; but there is no way to force a player to land on your property, or even to influence the chances that he will. There is almost no way to benefit another player to oppose a third, either—though it is possible to trade properties for mutual benefit, this occurs only rarely.

On your turn, you roll dice, move, and suffer or benefit from the consequences of the square on which you land. You have

only a few choices to make during play—whether or not to buy a property when you land on it, when to upgrade your properties with houses and hotels, whether to stay in jail or pay to get out—and other players cannot force, prevent, or affect any choice you make.

Does player unpredictability play *any* role in *Monopoly*? Yes, but only to a very slight degree; you cannot predict what choices players will make, on the few occasions when they have choices, but since you cannot influence them, their decisions have little to no impact on your own decisions. *Monopoly* is a game of near-perfect information—the only lack of perfection is that you do not know what cards will come up next in the deck, but these cards have only a glancing impact on play.

There is some strategy to *Monopoly*, but only a very little, and the optimal strategy is easily stated: always buy the first property in a block if you are able, always buy the third if you are able, and always buy if by doing so you prevent an opponent from assembling all three properties in a block. Upgrade to three houses as quickly as feasible, even if this means other properties remain without upgrades, since there is a substantial jump in rent between the second and third. Especially in the early game, always buy yourself out of jail if you can, because you will otherwise lose too many opportunities to assemble properties.

Because the strategy of the game is so simple—and invariant, there are no alternative strategies that become better under some circumstances—there is no real uncertainty in terms of the players' ability to master that strategy.

The uncertainty of *Monopoly* lies almost entirely in the dice. The player who is lucky enough to land on and purchase the better group of properties will almost certainly win. Luck overrides all other considerations.

This is fairly jejune in itself, but the reason *Monopoly* is ultimately dull is its excruciatingly extended endgame. By the end of the first hour, or at most two, of play, you can predict, on the basis of properties owned, who will ultimately win the game, with only a small margin of error. Yet to actually play the game to conclusion, you must play on for hours on end, slowly whittling away at the holdings of inferior players until they, at great length, are forced into bankruptcy. This is not a clever design.

Our point remains: *Monopoly* is multiplayer, but only peripherally affected by player unpredictability. Almost all of the game's uncertainty lies in the unpredictability of dice and, to a lesser degree, card draws—random elements. Only the theme and the paraphernalia of properties and houses and hotels and money hides from the players that they might as well be playing *Roulette*, and without the real-money risk and reward that makes *Roulette* of interest to those who play it. The appeal of *Monopoly* lives in its color, and not in its gameplay.

Chess

Chess is the abstract strategy game par excellence, a direct conflict of mind to mind, devoid of randomness, with an extremely simple rules set that nevertheless evokes enormous strategic depth.

Clearly, as a game that pits two players directly against one another, with gameplay dependent on capturing each other's pieces, player unpredictability is a main source of uncertainty. Given the lack of any kind of hidden information, you might expect that it was the only one; but in fact, there is another and deeper form of uncertainty.

To an external observer, a *Chess* game is an arrangement of pieces of different shapes on a square grid. *Chess* players themselves see it differently; each piece projects force across the squares to which it may move. *Chess* players are conscious of the interplay of forces, viewing the current gamestate, metaphorically, as rays of light and darkness extending across the board. In moving, they seek to alter the disposition of forces to their benefit, with an intermediate goal of forcing the opponent to sacrifice pieces and an ultimate goal of checkmate. In considering the next move, a player considers how it shifts the projection of force, how the opponent is likely to respond, and what the best response to that response would be.

To look at it another way, the game of *Chess* is an extremely complicated decision tree. In a given gamestate, the next player to move has a limited number of options, and each potential move can be seen as a branch from this node. Each move leads to a new gamestate, with each potential move of the opponent a branch from that gamestate. It's computationally possible, in principle, to parse the entire decision tree to find the optimal move (or a set of moves of equal optimality)—but impossible in practice, at least so far, because of the bushiness and complexity of the tree. *Chess*-playing programs typically combine an attempt to look ahead a few moves with a set of heuristics.

Human minds, of course, work differently from computers, and experienced *Chess* players don't make any effort to explore every potential branch of the decision tree; they have a gut understanding, fueled by study and the play of many games, that allows them to quickly dismiss most options and spend time exploring the more likely ones. In other words, the sort of pattern recognition that humans excel at, and which computers do not, is what allows humans to compete against computers

at *Chess*—not always successfully, of course—despite computers' superior speed in calculation.

The point here, however, is that no *Chess* player—human or computer—can truly cope with the strategic depth of *Chess*, at least until the endgame when the reduction in the number of pieces prunes the decision tree drastically.

The uncertainty in *Chess* lies not solely in the unpredictability of the opponent's move, but also in the player's uncertain ability to cope with the sheer strategic complexity of the game. The difficulty of analyzing the strategic options is so high that the player is rarely certain of the consequences of his next move.

Or, in other words, *analytical complexity* is the primary source of uncertainty in the game of *Chess*. There is perfect information, there is no uncertainty in the ability to perform any particular move, and there are no random elements; in a game of lesser depth, the combination of these factors would limit uncertainty greatly, perhaps leaving as a residuum nothing but the uncertainty caused by player unpredictability, as in *Rock/Paper/Scissors*. But because grappling with the explosive branching of the decision tree in *Chess* is so hard, uncertainty survives despite the simplicity and clarity of the game in other regards.

Analytic complexity is a source of uncertainty in many other games as well—but *Chess* is perhaps the purest example.

Roller Coaster Tycoon

Roller Coaster Tycoon (Sawyer, 1999) is a sim/tycoon-style game in which a single player builds and operates an amusement park. As with most games of the type, the player's main activity is building things—rides, pathways, decorations, concessions, and the like. Income derived from the player's operations can be

used to build more things, but initial capital is borrowed at an interest cost, so interest payments must be met and debts repaid.

While *Roller Coaster Tycoon* has a "sandbox" mode, the main game is a set of levels, each of which poses some challenge to the player—achieve some level of revenues, or some number of concurrent guests, and so on.

Patrons of the park are represented by small animations wandering the paths, waiting in lines, riding on the rides. Clicking on one shows something of the complexity of the underlying algorithms. Each patron's current state is represented by several values—happiness, hunger, nausea, energy, and money in pocket among them. Every few tics, each patron gets updated—happiness perhaps increased if on a ride, but nausea increased if the ride is intense, energy decreasing over time but refreshed by a rest at a bench, and so on.

Cynics have sometimes described sim/tycoon games as "animated spreadsheets," and there's some truth to this; under the hood, a set of fairly simple algebraic algorithms relates the statistics of rides to the statistics of patrons, moving patrons through the park, altering the player's revenues over time.

But if *Roller Coaster Tycoon* is a spreadsheet, it is not a simple one. As an example, intense rides cause some patrons to vomit. Unsightly vomit on the paths reduces the happiness of other patrons who encounter them. You may hire janitors, who move semirandomly about the park and remove vomit (as well as litter from concession patrons), but they require pay.

Clearly, unsightly vomit reduces the pleasure of guests, causing them to spend less time at the park and therefore spending less money; this also reduces the reputation of the park, meaning that the influx of guests will lessen, with a secondary negative impact on income. In other words, cleaning up the vomit

costs money, but failing to clean up the vomit also costs money. There is some optimal number of janitors for any given park configuration, but figuring this out is difficult. The algorithms are not directly exposed to the players, but even if they were, they could not be solved directly, since this is, after all, a computer program, executed as a sequence of operations rather than a static spreadsheet whereby the change to one parameter causes an immediate and straightforward change to other values. For instance, whether a patron encounters vomit depends on where he is, where the vomit is, his velocity of motion, potential changes to the direction of his motion, and so on; these factors are not easily predictable ahead of time, though one might model the rate at which guests encounter vomit statistically.

Consequently, even though *Roller Coaster Tycoon* is not anywhere as strategically deep as *Chess*, and is real-time rather than turn-based, it shares with *Chess* a fundamental attribute: both games are of sufficient algorithmic complexity that the consequences of a player's actions are uncertain, because the player cannot grasp all potential ramifications of an action.

The problem of analysis is compounded by the fact that the underlying algorithms are not exposed to the player. For instance, the farther a patron must walk before encountering the next activity, the more tired he will become, and the more likely he is to leave the theme park before spending all his money. Some arrangements of park features will therefore be more optimal than others, because they will offer opportunities to rest at the right moments, and new opportunities for fun on a schedule that dovetails with the patron's energy budget. But there is no way to know which of two options is preferable a priori, because the algorithm for decrease of energy with distance is not known, and it is not known how this character stat affects other aspects

of the game. Consequently, the best a player can do is to gradually obtain an intuitive sense of the workings of the system, and therefore make informed decisions based on gut feeling. This is a common factor of digital games: with tabletop ones, all aspects of the game are explicit and knowable, while with digital ones, many are hidden in code and not even in principle knowable to the player (short of decompilation and careful study of the code itself).[8]

Algorithmic complexity is not the only cause of uncertainty in the game; the game relies on randomness as well. Random factors govern the motion and choices of the patrons, the breakdown of rides, and the rate of guest influx, among other things. But the fact that the underlying algorithms harness randomness is not necessarily perceptible to the player; he simply knows that rides break down from time to time, and that it is necessary to employ some repairmen. Because of the number of guests, the random element of their behavior is also not perceptible to the player; while he may follow one guest closely at times, by and large he simply perceives a vast mass of patrons milling about and, antlike, engaged in behavior best viewed as a sort of statistical aggregate. To put it another way, as the number of random tests in a system approaches infinity, outcomes regress to a mean, and there are so many random tests here that players almost never see behavior that seems unusual. Randomness is being harnessed here for greater simulation fidelity, that is, as a way of representing factors over which the player does not have direct control, such as the behavior of his customers.

The *perceptible* uncertainty, therefore, and the cause of the challenge to the player's ability to master the system, derives almost entirely from algorithmic complexity and not from the random elements involved in those algorithms.

Poker

Poker is, of course, a gambling game, and there is a tendency to assume that all gambling games are games of chance—indeed, the legal definition of gambling assumes as much. In a game of chance, outcomes are largely or exclusively dictated by random factors—as with, say, *Roulette*. And certainly, there is a strong random element to *Poker*; the deck is randomized with each hand, and no player is permitted to know the order in which cards are arranged within the deck.

But from the perspective of uncertainty, *Poker* is actually quite a complicated game. Despite its relative rules simplicity, it possesses three distinct sources of uncertainty—moreover, those sources of uncertainty interact in quite interesting ways.

The first of the three sources, to which we have already alluded, is, of course, randomness. The second is hidden information—or its converse, partially revealed information. Consider the variety of *Poker* now most familiar to the world,[9] *Texas Hold'em*. At the inception of play, each player receives two "down" cards, that is, cards that only he is entitled to examine. Over the course of multiple rounds of betting, five additional "community" cards are revealed. The goal is to end with the best hand, by *Poker*'s somewhat complicated scoring system, using any five cards from among his own down cards and the common community cards.

Each player therefore has two data that the others do not: what cards he holds. Until the final round of betting, however, the player cannot know the true value of his hand, because any single new card may improve it. Indeed, in some cases, players remain in the game in the hope that, for example, the next card displayed will allow them to fill out a straight or flush.

Secondarily, the cards also tell the player that the others cannot hold the two that he knows he does; thus, if a player has a pair of Aces, he can be sure that no one else can have three, and that the likelihood of someone filling out an Ace-high straight is half the norm.

The player has no direct way of learning anything about the other players' cards; his only recourse to learn anything about them depends on his ability to read the expressions and body language of his opponents, or to learn from the manner in which they bet. Thus, if a particular player is betting heavily, one must conclude either that he believes himself to have a good hand or else is bluffing—and possibly his ability to read people may allow him to determine which is more likely. Similarly, over time, players may notice patterns of behavior in the actions of others, for example, that a particular player bluffs frequently or rarely does.

Players examine both their own and the community cards, taking into account the pattern of other players' bets, to attempt to model the thoughts of the others, in a fashion not utterly dissimilar from *Rock/Paper/Scissors*. That is, a player asks himself what the other players *might* possess. For example, if the community cards contain a pair, it is quite possible for another player to have a third card of the same type, and therefore trips—not a bad hand, particularly if the cards are high in value. Furthermore, players know which cards are in the deck, and can, on the basis of known information, calculate the likelihood that any particular hand is possessed. Some players, being fast calculators, in fact do so routinely, though others rely more on a gut intuition of probabilities, based on long experience with the game and many hands of play. Players combine an understanding of the odds, therefore, with theories about the mentalities of the

other players to try to understand what is going on, and determine their own likelihood of winning.

The third uncertain factor of *Poker* is thus player unpredictability—a factor particularly brought out by the bluff. The bluff is possible because players may fold during any round of betting, so it is possible to win by getting another player to conclude that he will lose, and should therefore fold rather than risk any additional stakes—even if he would have won had he stayed in the game. You bluff by betting aggressively at some point, hoping that players will conclude you have a stronger hand than in fact you do. Contrariwise, you can never be entirely certain that a player's pattern of betting is motivated solely by the cards he possesses; he can, in effect, as in *Diplomacy*, be lying.

Because card distribution in *Poker* is purely random and, in *Texas Hold'em* at least, cannot be affected by the players in any fashion, the strategy of the game does not lie in card play as such, but in betting. The ultimate goal is not to win or lose any particular hand, but to wind up with the largest amount of money over time—thus losing frequently is acceptable, so long as monetary losses on lost hands are more than compensated for by gains on rarer ones. Even the best player can never be certain of achieving this goal, however; he might err in his assessment of the odds, or in his ability to accurately assess the other players—and, of course, he might simply be foiled by ill luck.

Games of pure chance, like *Roulette*, rely for their appeal on the tension of winning and losing something of real and tangible value—that is, money. No rational person, after all, would play *Roulette* for the fascination of the game itself—watching a ball rolling around a wheel might be fascinating to a cat, but not to a human being—and it is hard to believe anyone would play it

for long for artificial rewards, for example, points or matchsticks. *Poker* is considered a gambling game because it relies partially on chance for its uncertainty—and also because it relies on the tension of monetary reward and loss.

But *Poker* is a far deeper and richer game than pure-chance games because randomness is not its sole source of uncertainty; hidden information alters the equation of the odds, and player unpredictability further complicates the situation. Mastering a pure-chance game, from a strategic point of view, is simple; the odds are calculable, and you always know what you are risking and what your reward may be. But mastering *Poker* requires far more—not just knowledge of the odds, but of how the odds mutate in the face of hidden information gradually revealed, and, more important, the ability to cope with and manage the complexity of unpredictable human behavior.

Rogue-Likes

Rogue-likes are named for the original game of the form, *Rogue* (Toy and Wichman, 1980), a text-based dungeon-crawling game originally available mainly on academic computers. The player controls a single character, with *Dungeons & Dragons*-like race, character class, level, and stats; as with conventional RPGs, of both the tabletop and digital variety, characters rise in level as they gain experience points, engage in combat with a variety of weapons (dying if hit points are reduced to zero), and gain equipment by slaying monsters and taking their treasures. The relationship to *D&D* is reinforced by the fact that players are exploring a literal 'dungeon,' a series of underground levels populated by monsters whose sole reason for existence is, seemingly, to be slain by adventurers who want their treasure.

The original *Dungeons & Dragons* contained a series of tables for use by gamemasters who did not wish to think too deeply about creating their dungeons; by rolling on these tables, you could create a (fairly lame) dungeon, generating monster types, number appearing, and treasure possessed. Another set of tables allowed you to generate "wandering monsters" you might encounter in the corridors between rooms.

D&D's random generation system is a poor substitute for an engaged and intelligent gamemaster, but Rogue-likes are a better substitute. They are experiences quite different from, and more engaging than, randomly-generated *D&D* levels. Rogue-likes take the notion of randomly generated content and run with it, creating algorithmically generated content of depth and character far beyond the simple patterns of *D&D*.

Rogue-likes are pure text games, with keyboard input; some more recent examples may have small illustrative tiles to replace ASCII characters, and recognize the occasional mouse click, but as a genre, Rogue-likes are the virtual antithesis of the conventional videogame, the creators of which are seemingly obsessed with ever more detailed and lifelike images.

The main tool Rogue-likes bring to creating interesting gameplay through randomness is algorithmic complexity far beyond that provided by a few 1D100 tables in the back of the *D&D* rulebook. In *NetHack* (Stephenson, 1987)—a particularly interesting example because of a multi-decade history of open source development by innumerable contributors—when you toss a ring down a sink (which is not a good idea, in general), the *sound* it produces (reported to you in text) indicates something about the type of ring you just threw away. That is, when you start a game of *NetHack*, it associates each type of magic ring that exists in the game (of healing, of fire resistance, etc.) with a random adjective

(garnet, pearl, gold, etc.). You find a "gold ring" and have no idea what it does, and you are reluctant to put it on, lest it be one of the bad rings (cursed ring of levitation, say, which lifts you up against the ceiling and cannot be taken off). If you toss a ring down the sink, you have lost it, but may, if you have done this many times before—or read the source code, since this is an open source game—be able to identify what a gold ring does by the sound it makes.

This is an obsessive level of detail, possible only in a game of long development by many hands—but it's typical of Roguelikes. Most of the content is algorithmically generated, meaning via a system using a random seed and lookup tables, though *NetHack* does have occasional "designed" levels with preestablished content. But there is so much variety in what these lookup tables can create, and so much attention has been paid to tiny nuances of gameplay, that even after many repeated plays, these games remain capable of surprising the player.

Randomness at this level has one strong advantage, as well as one strong disadvantage. The advantage is that no two Roguelike games follow the same path. Indeed, paths are likely to diverge quickly and to a high degree, even if starting from identical conditions (that is, with characters of the same class and race). One character may quickly obtain an item of great use to an early character, such as a ring of healing or invisibility, while another may read a scroll and be cursed to lug around a ball and chain. Randomness, in other words, is harnessed to create enormous variety of encounter; while the universe of all encounterable things in the game is by nature limited, there is such variety, encountered in so random a way, that the player is always uncertain what they will encounter next.

The disadvantage is the flip side of the coin: players often find themselves in impossible situations. Bad luck with magic items or monster generation can often doom a player, regardless of how optimally the game is played. In part, this is a reflection of the permadeath aesthetic of the game; Rogue-likes are specifically designed so that a player will typically need to attempt several hundred dungeon descents before winning. And indeed, the humorous nature of the deaths they create—"killed by a bugbear on level 32 while paralyzed"—are part of the genre's charm.

Randomness is not, of course, chaos. Within a particular level range, only a certain set of monsters will be encountered; they become tougher the deeper a player delves. But exactly what the player will encounter around the next corner is always uncertain, because of the random nature of the game.

Videogame players generally claim to dislike "randomness," rarely being aware of how deeply many games rely on random factors for either the generation of variety or simulation value. Despite this, Rogue-likes have ardent fans—and, indeed, *NetHack* is one of two games (along with *Civilization*) that have been on the hard drive of every computer I've owned since I first encountered it.

Like *Poker*, Rogue-likes depend on randomness as the main source of uncertainty; but here randomness is harnessed for variety, not as a source of strategy.

CityVille

CityVille is, as of this writing, the single most successful "social" game, meaning a game played on social networks, with almost 100 million monthly players—making it one of the most widely

played games in global history. It is also fairly typical of what we might call a "sim/tycoon lite" game—that is, of the same general style as richer sim/tycoon games like *Roller Coaster Tycoon* or *SimCity* (Wright, 1989), but with simpler user interface (UI) and gameplay more suitable to the "casual" audience that social games attract.

In *CityVille*, you build and place three basic types of buildings: municipal buildings, which increase the maximum population of your city; houses, which increase the actual population when built and from which money can be collected periodically; and businesses, which need to be supplied with "goods" and also produce money from "sales" to the population (though the game uses a statistical model rather than the simulation approach of classic sim/tycoon games).

Goods are obtained in a number of ways, including farming and via ships. Both systems require the player to select a period of time, from minutes to days, after which goods are collected; if not collected shortly after the appointed time, they "wither," a system to encourage player return.

At first glance, there seems to be very little uncertainty in the basic game model. Stats are exposed explicitly to the players; they know how much population a building grants, how much income it produces, and on what schedule. The number of experience points required to level up is open, and even such data as the effect of decorations on nearby buildings (they increase monetary yield by a small percentage) is explicitly reported to the player, via a fairly intuitive UI.

In other words, you can treat the game's economic model simply and algebraically; no math beyond the middle-school level is required, and there's no randomness or other source of uncertainty apparent in the model. Unlike *Roller Coaster Tycoon*,

you can represent the economic model with a fairly simple spreadsheet, and doubtless many players have.

And yet, those who denigrate this style of game often refer to them as "slot machines," implying that randomness rules. The reason for this is that when a player clicks on almost any entity to collect goods or money, reward icons (known in the industry as "doobers") spill out, slot machine-like, showing the number of experience points, money, and/or goods received. And there *is* a random element here: there's a chance of a slight bonus in terms of experience points, money, or goods—and also a chance that a "collectible" is received.

Collectibles, which players may view in a separate window, are grouped into "collections," and when all items in a collection are obtained, the collection may be "turned in" for a minor game reward. Those who view social games as slot machines maintain that the intermittent nature of these rewards is addictive, in a Pavlovian sense. That is, experiments have shown that an animal who always receives food when it pulls a lever will pull it only when hungry; an animal that receives a reward only intermittently will learn to pull it obsessively. Supposedly, the intermittent and semirandom nature of doober drops trains players to play obsessively.

Needless to say, game players are not chimpanzees, and the claim that this is a source of addiction is absurd; collectibles are a minor, charming draw—and in fact, their contribution to the game's uncertainty is equally minor. Collections *will* be completed over time and (at least in *Cityville)* completing a collection or obtaining a particular collectible is not critical to gameplay. (Some other social games make them more important.) After a time, players hardly notice which doobers are dropping. In other words, we need to look elsewhere for uncertainty in this type of game.

Doobers do produce another form of uncertainty, however; if you mouse over them rapidly and in succession to collect them, a “bonus bar” appears on the screen, with text beneath it becoming increasingly enthusiastic as you collect more. When you stop collecting, after a few seconds, you receive a monetary reward. If you collect only a few doobers, this reward is small, but if you collect many, it can amount to 3,000 or more in game money (soft currency), an appreciable reward. Generating sufficient doobers to get there requires you to plan your resource collection clicks and time them so the bonus bar does not expire until the maximal reward is obtained; there’s a degree of performative uncertainty in doing so. This is, in a sense, a minigame of doober collection within the overarching builder game, and a surprisingly engaging one, given its simplicity. Thus, there is some performative uncertainty in the game, albeit to a mild degree. The main sources of uncertainty still lie elsewhere.

Where do they lie? In four places: in the player’s own schedule; in dependence on other players; in the hidden information of the quest narrative; and in the expectation of future development.

Let us take them in turn. When farming or shipping, a player must anticipate the likely date of his return to the game, and suffers consequences if he fails to do so. Given the exigencies of life, this is uncertain. Quite often, real life intrudes, and you return to find a substantial investment in crops or shipping ruined.

While *CityVille* is largely a soloplay game, players affect each other at the interstices—and, in fact, progress in the game often requires *either* the cooperation of other players, or else the expenditure of real money.

Often, completing the construction of a building requires other players to respond to “requests”; often, completing a quest

requires other players to "help" you by sending a free gift (that is, one that does not diminish what they possess in the game, but benefits you). Furthermore, access to some content is gated by the requirement that you must have some number of "neighbors" in the game—social network friends who have agreed to this status. Similarly, you can obtain extra energy (a required resource) by asking friends for it, and withered crops or ship deliveries can be "unwithered" by friends.

In short, the game frequently prompts you to send requests to Facebook friends to provide things you need; and indeed progress requires them to respond positively, and within a particular period of time. Of course, the game always allows you to buy your way out of these requirements, with actual money; but even players who don't mind spending to play would prefer to advance without doing so.

The response of your friends is uncertain; while you are likely to be able to obtain what you need over time, it can be days, or possibly even weeks, with repeated requests over the network, before you do. Repeated requests spam your friends with network messages, and you may get sick of bothering them, motivating you to forgo a particular route of advancement or spend money.

On a day-to-day, moment-to-moment basis, these are the two main factors of perceptible uncertainty to the player: Will your friends respond, and how quickly? And will you manage to return on the right schedule or not? The appearance or lack of appearance of a collectible or two is hardly noticeable, and neither a cause of worry nor a triumph.

There's a degree of narrative uncertainty in the quest system, as well. At any given time, a player has a set of "goals" to accomplish, many part of a set of chained goals, with completion of one unlocking another. The goals serve several purposes for the

game's operator: Some are "tutorial," encouraging the player to use features of the game to ensure that they understand how to do so. Some are "narrative," with a small story arc that players may enjoy in its own right. And many are "grind" missions, ensuring that the player has a set of tasks to accomplish even if unsure of how to progress or what to do in the overall builder game at that point in time.

As a player, you do not know in advance what goals are important in terms of unlocking new and interesting content; nor do you know what the rewards for accomplishing one will be. The goal structure, in other words, is an example of hidden information, revealed only by play; players feel motivated to accomplish goals to see what comes next, the same kind of narrative anticipation aroused by fiction. Surprisingly, the rewards for goals are remarkably small; it's interesting that players feel motivated to accomplish them regardless. Narrative anticipation—another form of uncertainty—is a sufficient draw.

The final source of uncertainty derives from the fact that social games, unlike conventional PC and console games, undergo continuous development. The developers add new content and features on an ongoing basis, so long as the revenue generated by the game is sufficient to justify employing a "live team" to create new material. Even if a player has advanced far, and essentially consumed the available content, there's always an interest in seeing what new things the developers will create next. There's no way of predicting that, of course, unless you happen to sit in on staff meetings at the developer's offices.

What's interesting about the sources of uncertainty in *CityVille* is that, with the exception of the performative aspect of doober collection, *every one of them* ties directly into the game operator's business objectives. Those objectives are trifold.

First, the operator wants players to use the messaging channels provided by the social network, because at least some of these messages are visible to nonplayers and help encourage new players to join (virality).

Second, the operator wants players to message even those who have already joined the game, in order to persuade those players to return to the game and play further (retention).

Finally, the game operator wants to tempt players to purchase things in the game with the game's "hard currency," which unlike the soft currency is sparsely doled out and beyond a certain point must be purchased with real-world money (monetization).

The reason the operator has these objectives should be obvious: the greater the number of players, the longer those players continue to play, and the greater the number of players who are persuaded to part with actual money, the more money the operator makes. Virality, retention, and monetization are the watchwords of social gaming, just as distribution and marketing are for retail games.

Schedule uncertainty plays directly into retention: if you do not return to the game, your goods will wither. And if they do, you will be incentivized to message your friends to come unwither them, retaining them for the game operator as well.

Gating so much game progress by player messaging serves all three purposes at once: messages to existing players serve a retention purpose, messages to friends who are not yet players serve a viral purpose, and you may always buy your way out of any player assistance requirement.

Similarly, accomplishing quests often involves some player messaging, and sometimes expending scare energy, with additional energy gained by spamming or visiting friends, or via

purchase. In all cases, each requirement for completing a quest can be bought out with real money. Advancing in the quest narrative thus requires actions to benefit the game operators.

And, of course, the desire to see newly introduced content requires players to keep playing, directly playing into player retention.

In other words, the creators of *CityVille* know exactly where uncertainty lies in their game, though they may not think of it in those terms; it is the game's uncertain elements that they rely on most strongly for financial success. The essential nature of uncertainty in games could not be more clearly revealed.

Memoir '44

Memoir '44 (Borg, 2004) is a board wargame that simulates the D-Day landings and the battles in Normandy prior to Operation Cobra. Its game system is unusually simple by the standards of board wargaming; other wargames are among the most complex of nondigital games. Its system is also highly original, and because of its popularity, the game has spawned a huge number of expansions and follow-on titles adapting the system to small-unit conflicts in virtually every theater of the Second World War. Despite its originality, however, the game's players face the same basic concerns—and sources of uncertainty—as players of other board wargames.

The game comes with a number of different maps representing different battlefields, some drawn from real-world conflicts (e.g., the Normandy beaches), and others more representative of typical conditions during the war (e.g., a map depicting the hedgerows of Normandy). Each scenario starts with a set number and distribution of units on one of the maps; there is no

uncertainty about the order of battle or the reinforcement schedule.

The terrain is public information; no fog of war exists. In addition to physical terrain, there are often preestablished defensive fortifications, such as barbed wire or entrenchments. This information, too, is not hidden. Terrain and fortifications affect rate of movement, provide defensive advantages, and sometimes block lines of sight.

Each player has a hand of cards; each card permits a player to perform actions with a limited number and/or type of units, in a limited portion of the battlefield. For instance, a player might have a card allowing him to activate three units on the left flank, or a card allowing him to activate all his tanks, in whatever portion of the battlefield. During a player's turn, he plays one of his cards, moves and attacks with the permitted units, and draws a replacement card.

There are three basic types of units: infantry, armor, and artillery. Infantry may take four hits before elimination (represented by grouping four soldier pieces together and removing them as hits are taken). Infantry moves slowly, may not advance after combat, and is maximally effective in attack only when attacking adjacent units. Armor takes three hits, moves quickly, may overrun enemy positions, and attacks at full strength up to a distance of three hexes. Artillery takes only two hits, but may attack at a distance of up to six hexes, although its effectiveness declines with distance.

When a unit attacks, the owner rolls between one and three of the special dice provided with the game; the number rolled depends on the firing unit's type, range to target, and terrain. Each die is printed with two infantry symbols, one armor symbol, one grenade, a star, and a flag. The flag and star symbols are

normally misses, though some cards change their effect. A grenade is always a hit; an armor symbol is a hit only against armor; and an infantry symbol only against infantry. Thus, in a single die roll, there is a 3 in 6 chance of inflicting a hit on infantry, a 2 in 6 chance on armor, and a 1 in 6 chance on artillery.

To win, a player must earn some number of “badges.” Each time an enemy unit is eliminated, one badge is earned; most scenarios provide additional methods for earning badges, such as taking key positions on the map. Since both players are earning badges in play, this usually makes for a tense game, because it’s rare for a large lead to open up in the early game.

Where does the uncertainty lie? Clearly, between the dice and cards, randomness is an important factor. As I’ve argued elsewhere,[10] the fact that board wargames involve many, many die rolls means that the random nature this introduces is somewhat illusory. Given many random tests, the odds regress to the mean, so that winning by pure luck becomes less likely. In *Memoir ’44*, however, luck with the dice can play a strong role, particularly in the endgame, when units have taken casualties and the players may be closely matched in terms of badges; at that point, a lucky hit can decide the game.

However, luck in the card draw can be more important; there is nothing so frustrating as having a hand of cards that permits activation of only a small number of units, in a sector of the board where they can accomplish little. Contrariwise, having powerful cards at the right moment can easily tip the game your way.

As with all wargames, there is also a strong strategic element. On any given turn, you examine your cards and try to figure out which one will benefit you most; once you have done so, you try to determine which unit activations will be most beneficial. After that, you must determine precisely which moves and

attacks will advance your objectives most strongly. Although wargamers rarely think in these terms, this is, in essence, a form of puzzle solving: figuring out how to optimally use the limited resources you have available, given the complexities of the system. Your ability to determine the optimal move is uncertain, because of the strategic depth of the game. In other words, in addition to randomness, *Memoir '44* depends both on solver's uncertainty and analytic complexity.

Furthermore, there is a smidgen of hidden information, since you do not know what cards your opponent possesses and hence have difficulty anticipating their likely response to your actions. And, of course, as with any multiplayer game in which players can injure or benefit each other directly, there is a degree of player uncertainty.

Board wargamers are, in general, more tolerant of randomness than gamers of other types; they understand that warfare is complicated, and that even the most capable commander must deal with high levels of uncertainty, with elements they cannot hope to control directly. While the universe itself may be nonrandom, at least at a macroscopic scale, the easiest way to simulate elements beyond a commander's control is to treat them as random factors. Thus, randomness may increase the chance that a game is won or lost on the basis of luck, rather than excellent play; but it also increases the verisimilitude of the simulation, and "realism" is an important value for wargamers.

In short, while *Memoir '44*'s primary source of uncertainty, at least at first glance, is randomness, it is a far deeper game than this suggests. There are elements also of puzzle solving, analytic complexity, hidden information, and player uncertainty. Indeed, there are few games so rich in sources of uncertainty, and consequently of such replayability and tenseness.

Civilization V

Sid Meir's Civilization V (Shafer, 2010) is the most recent installment of the series originally created by Sid Meier. As in all versions of *Civ*, you begin with a single settler, a single military unit, and neolithic technology, eventually guiding your civilization into the space age. Though it can be played multiplayer (and version *V* works somewhat better in this mode than previous iterations), it is a game that takes hours to complete, and is therefore not particularly well suited to online, multiplayer play. Most games are played solo, with other civilizations controlled by AI routines (though, as with most game "AI," to call it such is faintly risible; opponents' actions are controlled by a fairly simple set of heuristics).

Version *V*, in particular, has been criticized by some as a lesser game than version *IV*, because some elements (such as religion) have been omitted and others simplified considerably; the developers doubtless wanted to try to sustain the appeal of the game for new players and perhaps felt that the series was accumulating more complexity over time to please its most devoted players at the expense of accessibility to n00bs, a phenomenon I've elsewhere dubbed "grognard capture."

Nevertheless, it remains a rich, deep game with many dimensions: military, diplomatic, economic, and technological. The tech tree of the game means that every game tends to move through the same succession of eras, and thus there is a sameness once you have played many times; but there are also elements that ensure that games take unique paths. Each of the civilizations (French, Japanese, Aztec, etc.) has a different character, with bonuses in some places that encourage different styles of play; the Aztecs, for instance, gain culture points for

killing enemy units and begin the game with Jaguar warriors, the strongest early-game military unit. Playing the Aztecs, you are encouraged to be militarily aggressive, particularly in the early stages. As Siam, by contrast, you gain additional food and culture from city-states (small nonplayer powers) with which you ally, and have an early-game building, the Wat, which increases your culture; you are encouraged to take a more pacific path.

Similarly, culture allows you to select national "policies" that differentiate your civilization from others; for example, in the early game, you may concentrate on policies under the Liberty, Tradition, or Honor categories.

Finally, the game can be won in several different ways: through world conquest, by having much more culture than the other civilizations, by building a United Nations and gaining a diplomatic victory, or by being the first to build a starship and reach Alpha Centauri (the closest star system to Sol). Particularly toward the endgame, your play will depend heavily on which style of victory you are aiming for.

The first element of uncertainty in *Civilization* is evident from the moment you start to play: you can see only a small area immediately around your two primitive starting units. The vast bulk of the world is unknown, shrouded in black. The world is generated algorithmically with each new game start; you have no idea whether you are on a small continent or a large one, what civilizations and city-states exist in the world and which are near you, what resources abound nearby and which are lacking, or how the geography of the world will shape military and strategic considerations. You know, at least if you have played before, what types of terrain can exist, and a "minimap" reveals your latitude; you know what types of resources are out there.

But beyond that, the information is hidden. Much of the early game is spent exploring.

Resources are critically important to your play; a city founded near important luxury production sites will find it easier to maintain happiness (important for maximal production from your citizens), and some resources will provide a major boost to production, population growth, or taxes in the early game. In addition to that, other resources become critical as the game progresses: You cannot build units such as swordsmen without iron, or aircraft without aluminum—and the locations of these resources are not revealed until you develop the corresponding technology. Sometimes you find yourself moving along nicely, only to discover that all the aluminum is outside your reach, and your goal of getting to Alpha Centauri is therefore blocked—unless you initiate a war to conquer the resources you need. Moments such as these are among the most interesting of the game, and they work to knock you out of the normal flow of play, sit back, and ponder what to do next.

The AI opponents, too, are somewhat unpredictable. Each has a personality, and you learn to gauge these over time: the Aztecs and Mongols are militarily aggressive, the Siamese and Indians will be peaceful, the Americans will expand quickly, the Germans will drive up the tech tree quickly, and so on. Yet you can never be sure if and when they will declare war on you, try to take control of a city-state you counted as yours, or decide to end a trade deal. Because you can never quite be certain, you are forced to plan for contingencies—perhaps maintaining a larger military than you would desire against the risk of attack, or working to found a new city quickly to close off an avenue of expansion for a competitor.

In the endgame, it is often difficult to judge what style of victory each of the remaining civilizations is going for, and therefore what you need to do to thwart them, or how close each is to obtaining their goals.

In short, even though the opposing civilizations are controlled by AI routines, they are unpredictable enough that there is, in essence, a form of player uncertainty to the game.

Another source of uncertainty lies in the game's system of "wonders of the world." During the game, each city you control is always working on producing something—often, new units, but equally often, on new buildings to improve the city's capabilities. Wonders are a type of building, but unlike other buildings, are unique to the world. Thus, there can only be one Hanging Gardens and one Three Gorges Dam. If an AI opponent builds a wonder before you, you may not then build it yourself (and if a city has been building toward it, that city must change its production to something else). Since you do not know what opposing cities are doing, you do not know what wonders others are working toward, or how close to completion they are, until the wonder is revealed; thus, the competition over wonder construction is an aspect of both hidden information and player uncertainty.

Randomness plays a role: random tests are used in the algorithmic generation scheme for world generation, of course, but in addition, combat is resolved in a semirandom fashion, with each attack by a unit doing a variable amount of damage, within a particular range. *Civilization V*, in contrast to previous versions, alerts you to your likely degree of success or failure before you commit to an attack, but the randomness inherent in the system makes it uncertain: you might still win against the odds, or lose despite them. Consequently, warfare, except when there is a

major technological disparity between the opponents, is always tense.

Another form of uncertainty is fog of war. Although the map is revealed as it is explored, only units within a short distance of your own cities and units are visible; hence, you do not know what military units your opponents possess. While their technological advances are reported, you can sometimes be subject to a nasty surprise at the size and advanced state of an opposing army.

Finally, the depth and variety of the game system make achieving your objectives uncertain. While information about the economy is exposed, it is often difficult to judge what to build in a city next, what technological development will benefit you most, or what national policy is the right thing to adopt in the current circumstances. As players gain experience, they learn the ins and outs of the system, but it is still sufficiently complex to be hard to master.

Civilization, in short, has many different sources of uncertainty—more than most games, in fact. This makes it a highly repeatable and compelling experience.

Magic: The Gathering

Magic: The Gathering (Garfield, 1993) is the original trading card game; it swept the hobby game market by storm when first published and retains enduring popularity. It was hugely innovative, both in terms of gameplay and business model. Players purchase cards, either in the form of “starter decks” or “booster packs”; starter decks are designed to be playable out of the box, while booster packs are a random assemblage of cards you may use in play.

To play, each of two players assembles a deck; that is, they select a suite of cards from among all they own. *Magic* is an exceptions game; that is, the basic rules are fairly simple, but many cards have special rules printed on them that must be learned and applied only when the card comes into play. Thus, though the basic structure is easy to learn, the entire universe of possible rules is huge.

The basic structure is that players play "land" cards in front of themselves that provide a certain amount of magic each turn (in five different colors). These magic points may be used to introduce other cards into play, each having a cost in terms of magic points, often requiring points of a specific color. Cards include creatures, which can be used to attack an opponent or defend against their attacks; spells that have some immediate effect; and spells that can be attached to creatures to modify their capabilities. Each player has twenty hit points, which erode as they are subject to successful attacks. The objective is to reduce your opponent to zero hit points.

Interestingly, the strategy of the game lies primarily in deck construction, rather than decision making in the course of play. There are a huge number of unique cards in the *Magic* universe—several hundred when the game launched, and more than ten thousand today (counting all cards published over the course of the game's history—not all are in print today, but can still appear in a player's deck). In building a deck, your objective is to assemble cards that work well together, reinforcing the capabilities of other cards; sometimes you have a particular opposing deck in mind, the deck of a friend who beat you and whom you want to beat in return by finding its vulnerabilities. Other times, you want something that you think will be strong against many opponents. Because of the huge variety of cards, decks

have strong personalities: one might be built around powerful attack spells and a screen of defending creatures; another around cheaply cast creatures and spells to make them more powerful; a third designed simply to survive as long as possible, with the maximum permitted number of cards in the deck, and with cards to make your opponent cycle through his deck quickly. (One way to win is to have your opponent exhaust his deck before you do.)

Consequently, one source of uncertainty in play is caused by the huge variety of cards; generally, you do not know what cards your opponent has in his deck, what strategy they are aiming for, and often, you will encounter cards you have never seen before. This is, indeed, part of the fascination of the game: the sheer variety it offers, and the cleverness of players in combining cards in effective ways. The game exhibits a combination of player unpredictability, analytic complexity, and hidden information.

Before playing, you shuffle your deck. One rule of *Magic* is that while you may have multiple instances of a single card in your deck, no card may be present more than four times, and decks are typically on the order of sixty cards. Consequently, you are not assured of getting a card you may consider vital to your strategy out of the deck in the early game, or possibly even throughout the game. You can, in other words, be screwed by the randomness of the draw; you may find yourself with many lands but not enough creatures to provide an adequate defensive screen, or conversely with hugely powerful spells and not enough lands to provide the magic power to bring them into play. In other words, your own strategy can be thwarted by the randomness of the game; as in *Poker*, even a very powerful deck can sometimes be beaten by a weaker one, through luck of

the draw. Clearly, randomness is part of what makes the game uncertain.

The huge rules set of the game as a whole, coupled with the huge variety of cards, makes deck construction an exercise in parsing through your available cards to create an interesting and powerful deck; there's an element of analytic uncertainty here, since the options are manifold. Despite this, algorithmic complexity is rarely an element of uncertainty in actual face-to-face play. When it is your turn, you have a limited number of cards in your hand, and limited options in terms of which you may play. The cards you and your opponent have already brought into play are now known factors. Frequently, the right move to make is obvious from these factors; *Magic* is not the sort of game that provokes analysis paralysis, with players spending long minutes pondering their options. There is, in other words, little uncertainty in moment-to-moment gameplay, except for the uncertainty of knowing what cards will appear next—and, of course, the hidden information inherent in the unknown nature of the cards your opponent holds.

Randomness is a factor in *Magic* not merely during face-to-face play. Players obtain most of their cards through the purchase of booster packs; the cards in a booster pack are assembled at random (subject to rules that make some rarer than others). Consequently, when you purchase and open a booster pack, you are always uncertain what you will obtain—and may experience delight at finding a new card that works well with others you have, or disappointment at receiving cards that duplicate ones you already have, or worse, quintuplicate them—meaning you already have the maximum of this card you can use in a single deck. This is, of course, one reason *Magic*'s business model is so effective: there's always a temptation to buy more cards,

and players can be induced, in essence, to spend the maximum amount they are comfortable spending on their game, whether that be a few dollars or a few thousand.

Finally, *Magic: The Gathering*, almost uniquely among tabletop games, shares with social games like *CityVille* what you might term development uncertainty. Wizards of the Coast, *Magic*'s publisher, releases new cards on a quarterly basis. Consequently, even if you have grown bored with the cards available to you and the options they permit, there's always new content to be explored, a new set of permutations to be mastered. As we saw with *CityVille*, this is an important aspect of player retention for social games, and equally so for *Magic*.

Gardens of Time

Gardens of Time (uncredited, 2011) is, like *CityVille*, a social game, developed by Playdom, a Disney subsidiary, and my employer. (I had no hand in its development.) I discuss it here, because its core appeal derives from a form of uncertainty we have not previously addressed.

Like many social games, *Gardens of Time* has a "builder" aspect, the garden of its name; players purchase decorations for their garden with game currency, and expanding the total decorative value of their garden unlocks other aspects of the game. There is very little uncertainty here.

The core of the game, however, is hidden object gameplay. In this, it is not original; hidden object games were previously among the most popular of genres in the casual-downloadable market, and are also popular in print form, with books such as *Where's Waldo*. *Garden of Time*'s originality is in marrying such gameplay to a social network frame.

At game start, a handful of hidden object scenes are available to the player, and game money is earned mainly by "playing" them. Spending this money on garden decoration unlocks additional scenes.

Each scene is supposedly in the past (or future) and is a busy illustration: a room containing many objects, for instance. Though there are a number of different modes of gameplay, the most common is this: along the bottom of the screen, the names of six objects appear—statue, gold coin, feather, and so on. Each of these items appears somewhere in the illustration. When you locate one, you click on it; this scores you points and removes the item from the list, replacing it with another—at least until six have been found, because one session requires locating twelve objects in total. If you identify a second object within a short period of time, you gain additional points; a maximal score is gained by identifying all objects in sequence without any "time-outs" between them. In the first play-through of a scene, this is virtually impossible, because the busy-ness of the image makes it hard to pick out these items.

However, players are encouraged to play a single scene multiple times. The items called out for identification with each session are varied; essentially, the twelve you are asked to find in a session are drawn at random from a longer list of perhaps twenty-four, so while on your second play, some of the items you found previously may be included, there are likely to be new ones. You will be likely to find them more quickly, even the new ones, because you have spent some time examining the scene, and even if you were not previously asked to find the dog collar, say, you may have noted its presence.

The game contains a "mastery level" system, awarding a player a new level within a scene for achieving a certain cumulative

score; new items to find are added to the list for random selection with each level of mastery, ensuring some variety for players over time. Even so, by the time a player achieves the highest level of mastery in a scene, he will likely be finding the objects quickly and may well be able to find them without timeouts.

Where is the uncertainty in this? Initially, the uncertainty lies in your ability to spot items quickly; later on, it lies in your ability to recall where they are and to keep moving ahead of the timeout clock.

This isn't performative uncertainty, in the sense I use it, because this is not a physical task; it isn't solver's uncertainty, since there's no puzzle involved. You could call it a form of hidden information, except that it isn't, really; it's all out there, in the image, hidden only by the difficulty of parsing a busy picture.

The uncertainty lies in your ability to perceive, to use your eyes to translate a word of text to some artists' rendering of that item—sometimes, in fact, different words refer to the same item (die, or cube, for instance). Call it uncertainty of perception.

5 Sources of Uncertainty

We're now equipped to examine the sources of uncertainty in games more closely.

Performative Uncertainty

I've restricted the term "performative uncertainty" to mean the uncertainty of physical performance. In today's conventional videogame market, games of performative uncertainty rule: first-person shooters, action/adventure games, driving games, and the like. Indeed, many videogamers view challenges of hand-eye coordination as inseparable from the very idea of "the video-game," though of course there are in fact many digital games for which this is not true: turn-based strategy games, adventure games, and so on.

One school of thought holds that games of performative uncertainty, or player-skill games, are inherently superior to character-skill games, or to games of analytic complexity, which are often derided as "animated spreadsheets." The notion is that "real gamers" should develop l33t skillz, and anything else is an inferior experience.

The problem with depending on player skill, however, is that, by nature, players are not evenly matched. A new FPS player, signing onto a multiplayer server, will die over and over, at the hands of more experienced players—not a positive player experience. It's no fun to feel as if you have no chance; any uncertainty departs.

Of course, there are ways of redressing this problem—having a scheme to match players by experience, for example. But designing any such system is tricky, and none is perfect.

Equally tricky is the problem of tuning performative challenge in a soloplay game. Almost whatever you do, some players will find the game too easy, and others too hard; those who find it too hard will abandon it, and feel that the money they paid for the game was not well spent, while those who find it too easy will be similarly dissatisfied. Moreover, developers tend to listen to their most ardent fans, who are by nature hard-core and more skilled than the general audience, and therefore tend to develop games that satisfy the hard core, at the potential expense of reaching a wider audience; indeed, over time, particular genres become harder and less newbie friendly, the phenomenon of grognard capture. Anyone could play *Doom*; only someone who grew up playing FPSs can master more recent titles, particularly at the highest difficulty setting.

Developers try to deal with this problem using variable difficulty settings, or dynamically adjusted difficulty, but even the "easy" setting in many games is beyond the capabilities of some players. For my part, there are bosses in, say, the *Zelda* games I cannot beat, my strategy typically being to hand the controller to a teenage daughter and tell her "five bucks to beat this boss."

While it is possible to construct a player-skill game that is fairly casual in nature—*Tetris* (Pajitnov, 1984) and *Snood*

(Dobson, 1996) are examples—games of physical challenge tend to be "lean forward" rather than "lean backward" in nature. That is, they typically require continuous attention from the player and excellent timing for success; they are tense, not relaxing. Lean backward games, by contrast, are less tense, do not require continuous attention, and are played more for relaxation—match-three games such as *Bejeweled* (Kapalka, 2001) for example. Consequently, games of performative skill are less likely to be successful in more "casual" markets.

Games of performative skill tend also to be "blue" rather than "pink"; I don't wish to make broad assertions about what sorts of games women and men prefer, because people are different, and almost any such assertion is falsifiable. But observably, the most hard-core of player-skill games attract a largely male audience, and the sorts of games that appeal most strongly to a female demographic—casual and social games—are either devoid of performative challenge or tuned very low in terms of difficulty.

Some gamers find performative challenge to be undesirable in games, rather than essential. Abstract strategy gamers find games that rely on anything other than a clean mental contest unappealing; strategy simulation gamers are interested in simulation verisimilitude and not in mastering a set of reflex actions; casual gamers often find player-skill games frustratingly hard. Thus, as in so many things, whether or not performative challenge is appropriate and useful in a game is almost entirely a matter of aesthetics.

Solver's Uncertainty

Solver's uncertainty was rare in games before the digital era, although present in some: in *Cluedo* (Pratt, 1948; published as

Clue in the United States), determining the murderer, room, and weapon is a kind of logic puzzle.

Most tabletop games are algorithmic, rather than instantial, meaning that the game's "content" is algorithmically generated by the nature of its system, and not a set of predesigned elements that are less interesting on second exposure.

By contrast, most digital games are designed to be played once, with no compelling reason to want to play a second time. Puzzles, each of which have one or a handful of solutions, are therefore eminently suited to digital games of this sort.

While there are games, like *The 7th Guest* (Devine and Landeros, 1993), that incorporate classic puzzles, the puzzles in most digital games derive from the game's own rules of interaction. For instance, in *The Incredible Machine* (Ryan and Tunnell, 1993), the player is given a series of objects, each of which has a strictly defined set of behaviors—ropes and pulleys, for instance—and must combine them to accomplish a particular task. Or, as another example, in the excellent *Deadly Rooms of Death*, you control a single character with a sword, and each turn you may take one action—with all enemies taking an action immediately afterward. Enemy actions are always predictable, and each "room" has at least one solution, a sequence of actions you may take to traverse the room and clear it of enemies.

In other words, most puzzle-based games are composed of elements created for the specific purpose of enabling the development of interesting puzzles. The problem with this, however, is an inevitable sense of artificiality; while there may be a metaphorical connection between the puzzle elements and real-world entities, their behavior is explicitly defined by the game, and only the rules of the system determine permissible behaviors. In puzzle games, there is, typically, scant possibility for a player

to devise inventive and creative solutions to a problem; instead, he must, in essence, try to read the game designer's mind, try to imagine what solution the designer envisioned. This is particularly true of graphic adventures, with their reliance on inventory puzzles and the combination of inventory items; the solution to a puzzle in a graphic adventure does not, as with most puzzle games, depend on an understanding of the behaviors of game elements, but instead on an often arbitrary, designer-established, specific combination.

As an example, in the original *Zork: The Great Underground Empire* (Blank, Lebling, et al., 1980), I was stymied for a long time by a puzzle I needed to solve to open a particular doorway called "the gates of Hell." I had a bell, a book, and a candle, knew that these are elements used in real-world exorcisms, and surmised that they could be used to open the door. In this, I was correct. I also knew that the phrase is "bell, book, and candle," and therefore attempted to ring the bell, then read the book, then light the candle. This did not work, nor did any number of other possibilities I tried. It was only when I tried using these three elements in all possible combinations that I uncovered the solution; you must light the candle before reading the book, and then ring the bell—the reverse of the order I had assumed was required.

Now doubtless the game's designer had reasoned that you need light to read by, and thus the candle must be lit before the book is read, and that you ring bells to open doors and therefore this element should be last; but there is no a priori reason to value this line of reasoning over my own, that the items should be used in the order defined by the common English phrase. In an ideal world, either the failure message from my attempt should have given me a clue as to why I had failed, or perhaps

the designers should have permitted both approaches to work. But the result of this was considerable player frustration, which is rarely a desirable outcome in a game. In short, the solution to the puzzle was both arbitrary and artificial, requiring, as previously said, an attempt to read the designer's intentions.

This kind of artificiality is inevitable with any game in which puzzles are one-offs and do not emerge naturally from puzzle elements. The contrast is with games in which each game element has a predictable behavior, which are arranged in particular combinations to create puzzles. An excellent example is *Lemmings*; in each level of *Lemmings*, you must guide your little creatures (the eponymous lemmings) safely across the level and out the other side. You can create some special lemmings with defined behaviors, such as ones that build ramps, ones that explode and destroy nearby obstacles, and so on. The geography of each level is designed in such a way that some combination of lemming powers can be used to traverse the level; there is none of the sort of arbitrary reference to real-world entities that complicates and often confuses the issue in graphic adventures.

Lemmings is a complicated enough system that there are often less efficient and more efficient ways to solve a particular level (efficiency based on the number of lemmings that die in the process—fewer being better). However, there is a maximum number of permitted deaths in a level, and the puzzle elements permitted to the player within a level are highly constrained; thus, the player needs to be close to maximally efficient. And while this kind of game avoids the sort of artificiality that requires reading the game designer's mind, it has another sort of artificiality: the rules of the system are arbitrary. In the real world, there are no exploding lemmings, nor ones that build ramps; there is no connection to real-world phenomena. There is no opportunity

for “creative” solutions; typically, there is only one solution to a level, and the only variation is in how quickly and efficiently you find and implement it. It is a finely structured game for those who enjoy mental challenges, and the lemmings themselves are cute; but for those who enjoy rich narrative, systems that permit a degree of creativity and self-expression, the kind of spectacle that many videogames offer, or a sense of skill-based mastery, it has little to offer, since it is so tightly focused on puzzles. By this I do not mean to criticize the game; *Lemmings* is an excellent game of its type. Rather, I mean to point out some of the difficulties involved in incorporating solver’s uncertainty in games.

That being said, if you look for solver’s uncertainty, you'll find that it turns up as an embedded element in many games that are not primarily concerned with puzzles. For instance, in a turn-based strategy game, a player must, each turn, try to solve the puzzle of how to make the most effective attack with the limited resources available to him at that point in time, given the opposing disposition of forces and the terrain on which combat occurs. In an action/adventure game, a player must often try to deduce the precise sequence of events that will bring down a boss, given the boss’s visible and repetitive behaviors, the layout of the level in which the confrontation takes place, and the tools and verbs available to the player. And in a hand of *Poker*, figuring out whether to check, raise, or fold is a puzzle that involves considering what you know about the other players’ hands, what cards remain in the deck, and the likelihood that your hand will improve given your own cards.

To put it another way, almost any multivariable strategy game creates puzzles, but these puzzles, unlike those of explicit puzzle games, emerge from the complexity of the mechanics of the game itself; one way to improve a strategy game is to

consider whether the puzzles it creates are sufficiently interesting in themselves, and if not, what change in mechanics might make them so.

Player Unpredictability

In principle, any multiplayer game can harness player uncertainty, but as we saw in the case of *Monopoly*, not all do. In general, it's hard to see why multiplayer games *shouldn't* exploit it in some fashion, except perhaps in the case of games designed for players of very divergent skill, such as games played by adults with children. In such games, allowing one player to gain an advantage by adversely affecting others skews it too much toward better-skilled players.

The simplest way to enable player unpredictability is to allow players to "attack" each other, by which I do not literally mean in a military fashion, but to affect each other in either a zero-sum (your loss is my gain) or a negative-sum (your loss is either a lesser gain to me, or also some loss to me) way. An example of a negative-sum interaction, in fact, is a military attack: if I attack you, I am likely to suffer some loss of manpower or units, even if I am victorious.

If attacks are feasible, players must always work to increase their offensive and defensive powers, and they must try to determine the likelihood of attack and the effectiveness of an opponent's potential attacks. If, as is often the case, increasing offensive and defensive power involves trade-offs against achieving other goals, players have a tasty set of uncertainties to grapple with. And if, as in *Diplomacy*, players can effectively ally and/or backstab, the need to negotiate with and try to model the behaviors of others becomes important as well.

Player uncertainty can also play a role, albeit a less tense one, even in games that permit only positive-sum (we both gain) interactions. For example, in many Eurogames, such as *The Settlers of Catan* (Teuber, 1995) trading is a critical element, and few players can advance far without engaging in trade with others. The game is designed so that all players are likely to have a surplus of some trade goods and a deficit in others, encouraging them to trade. And yet *Settlers* permits only a single winner, so players must also consider whether a proposed trade benefits themselves more than their opponent, and also where they stand relative to that opponent—a player far in the lead might well agree to a trade that advances the trade partner more than himself, so long as this increases his own lead over other players.

Player unpredictability of this kind can play a role, strangely enough, even in games in which the standing of one player is basically irrelevant to that of another. In the social game *Empires & Allies* (uncredited, 2011), for instance, a player may "attack" another, eliminating some of the opponent's units and occupying some of the opponent's territory. However, unlike a conventional wargame, "occupying territory" just makes it a little harder for the opponent to collect resources from the area, until the attack is "repelled," either by the target player or another player who happens to visit. The attacked player is injured; the attacker gains some (fairly small) benefit; but since there is no overall winner or loser, and as with most social games this is mostly a soloplay builder with player communication at the periphery, it does not, in the long term, really matter. Moreover, since social games seek to retain players for as long as possible, and since seeing your position destroyed by attackers is not likely to keep you playing, the game strictly limits how much damage a particular attacker can do; attacks are an annoyance, cannot destroy

anything you have built (other than a few units), and only modestly reduce your resource collection capabilities. And yet these attacks have value for the game, because they make its universe feel more alive, as if you are actively playing with others who are unpredictable and who can either help (via gifts) or injure you; *Empires & Allies* feels more like a genuinely multiplayer game than most social games, despite the fact that it is at its core, the same kind of soloplay builder as so many others. There is also, of course, a business objective here; games that support player versus player (PvP) behavior tend to monetize more effectively (produce higher average revenues per daily active user [ARPDAU]) than those that do not, at the expense of excluding more casual players who do not like this kind of mechanic.

Player unpredictability does not depend solely on actions that directly injure or assist others; it can also exist in games that permit one player to take actions that either close off or open up opportunities for others, without affecting them directly. For example, in *Puerto Rico* (Seyfarth, 2002) each player chooses an action, which all players may then perform, but with some additional benefit for the selecting player; at the end of a turn, some actions remain unchosen, because there are always more available actions than players. By selecting a particular action, you deny other players the special benefit conferred on the player who chooses it, but you also allow them to take the action, which benefits them; of course, you try to select the action that benefits you most and others least. But you are not directly engaging with other players; you are opening up or closing off options to them.

Eurostyle boardgames are sometimes accused (by those more comfortable with directly competitive games) of being “solitaire games played together,” the conceit being that since players

cannot injure each other directly, the only real conflict between them arises through endgame scoring. This is, in fact, an unfair claim; rather, Eurostyle games tend to avoid direct attacks because games that permit this are viewed by those who enjoy the genre as being "too nasty." There is still competition among the players, and a player's actions are contingent not merely on what benefits them most, but also on how an action will benefit or deny benefits to others. It is true that interactions, and competition, are not as direct as in a more "Ameritrash"[1]-style boardgame, but this merely means that the conflict among the players is indirect, and that players must be more clever about how they work to injure their opponents.

Because player interactions are so rich a source of uncertainty, many soloplay games try to provide a sense of it with AI opponents. These can vary from enemy soldiers engaged in flocking behavior in a mass-scale combat game like *Rome: Total War* (Smith, Brunton, et al., 2004), to individual AI opponents in a soloplay FPS responding to notional aural or visual cues, to an entire civilization opposing yours as in *Civilization*. The problem, of course, is that real humans are inevitably sneakier and less predictable than AI routines, and "the AI sucks" is a common refrain from gamers. If you look more closely at AI code, you'll find that it, like all code, is procedural and predictable, except to the degree that it contains some random element to reduce the predictability; of course, if sufficiently complex, the algorithmic complexity of the system may make its behavior more unpredictable to the player, if wholly predictable from a systems point of view. Still, you can parse this and perhaps say that the source of uncertainty here is not truly "player unpredictability": there's a degree of hidden information, since the source code is not available; if the AI algorithms are complicated,

there's a degree of analytic complexity; and if there's a random element involved, that also provides uncertainty. So in a sense, AI opponents harness different kinds of uncertainty to provide players with the illusion of player unpredictability.

Randomness

Many gamers dislike, or think they dislike, randomness in games. That's true of many different kinds of gamers: abstract strategy gamers eschew games that depend on anything other than a mental contest, and skill-and-action videogamers want to feel that they win through l33t skillz, not luck. For that matter, Eurogamers prefer games that allow them to feel that (a) winning is accomplished through superior strategy and (b) any random elements are peripheral and unlikely to affect outcomes strongly.

And yet games with strong random elements are among the most ancient, common in every human culture. In a series of books for the Smithsonian at the turn of the last century, Stewart Culin documented the games of dozens of neolithic cultures.[2] Almost all cultures have what Dave Parlett calls "race games,"[3] games in which players use a random number generator—dice, or binary lots such as knucklebones or cowrie shells—advancing a token along a track (sometimes just a set of lines drawn in the dirt) on the basis of the random cast, with the winner being the player to reach the end of the track first.

Of course, randomness has, for ancient cultures, an aspect that is less resonant to most modern people; as a civilization based on scientific rationalism, we know that randomness is just randomness. For most other cultures, "luck" is a seemingly real, not illusory, phenomenon, and randomness may be a way of

testing your favor with the divine. Lots are often cast for divinatory purposes, as with the *I Ching*, and indeed, some race games may have been originally devised as a mechanism for recording the outcome of divinatory lots.

Some games, such as *Roulette*, depend almost wholly on chance; however, such games are, for the most part, used only in a gambling context. Risking real money stakes produces a sense of tension that concentrates the mind on the outcome; without such stakes, these games are, for most players, dull, precisely because the player has no ability to affect the outcome in any fashion.

The other class of games that depend wholly on luck are those that are designed for adults to play with children, such as *Candy Land* (Abbott, 1949). Even here, however, the luck-dependent nature of the game is partially hidden from the naïve player, for whom the tasks of drawing cards, advancing tokens correctly, and taking turns provide a sense of "game-ness" even though no real decisions are being made and no real test of skill is involved.

Some games that are highly dependent on luck for uncertainty are, despite this, very much skill-based games. *Poker* is the classic example; card distribution is random, but the statistics of the system are algorithmically complicated because it is a nonstochastic system. In a stochastic system, each event is unrelated to the previous one—die rolls are an example. In a nonstochastic system, the previous state of the system does have an effect on its evolution; once one card is known, the odds of drawing other cards, or of obtaining a card that will improve your hand, shift. It is beyond most players' abilities to accurately recalculate odds with each revealed card. Thus, the randomness of the system itself fosters, rather than diminishes, strategic play. There are certainly other ways in which skill plays a role in *Poker*—bluffing,

reading others, and choosing a betting strategy—but the way in which strategy emerges from, rather than is diminished by, the randomness of the game is part of the game's fascination.

Many games harness randomness as a means of creating moment-to-moment uncertainty, but reduce the overall effectiveness of randomness by performing many random tests, each of small weight. The idea here is that, with many random tests, the system regresses to the mean; if a game is dependent on a single die roll, it is highly random, but if there are dozens or hundreds of die rolls, each of modest impact, the likelihood is that the overall results will be within a narrow range of the bell curve, not at one extreme or another. Thus, in a board wargame, a player is never certain of the outcome of any individual attack, but over the course of the game, it is unlikely that his luck with the dice will dictate the outcome; rather, it is more likely that his ability to figure out how to arrange his forces for maximum impact will be the determining factor. In games like this, randomness has a positive aspect beyond creating a degree of uncertainty; it provides simulation value, because in reality, a military commander can never control everything that happens on the battlefield, so "random factors" stand in for all the myriad issues that create uncertainty in a chaotic struggle.

Another common use of randomness is to break symmetry. That is, many games begin symmetrically, with all players in equal and equivalent positions, in order to ensure game balance; the problem with this is that unless symmetry is broken, all players are likely to value resources equivalently, adopt very similar strategies, and be able to judge quite easily where they stand relative to one another as the game progresses. It is desirable to break this symmetry, in order to provide uncertainty among the players about the other players' objectives, goals, and standing;

and one simple way to do this, without unbalancing the game, is with some random distribution of assets, either at the start of the game or as the game progresses. Thus, for instance, in *Ticket to Ride* (Moon, 2004) the initial distribution of route cards means players will seek to build tracks in different regions of the board. Similarly, in *Empires & Allies*, each player is able to produce one, and only one, type of metal (iron, copper, aluminum, and uranium); this encourages players to trade with one another, provide gifts in the hope of receiving gifts from others, and visit friends to obtain some of the kind of metal they produce. The distribution of resource types is random, but it fosters behavior the game operators find desirable: gifting, player visits, and trade, all mechanisms to encourage the use of social network virals, and thereby foster player retention and acquisition.

Another common use of randomness is to provide variety of encounter, that is, to ensure that players are uncertain about what obstacles they will face next in the game. This can be seen in a wide diversity of games. In *Magic: The Gathering*, the next card draw is uncertain not only because of the nature of card randomization, but also because of the wide variety of *Magic* cards in existence, and the fact that the cards owned by your opponent, and selected for their deck, is hidden information. In *NetHack* and other Rogue-likes, the level layout and the monsters and treasure to be found therein are generated at random, and thus each new game will be different from the last. Using randomness in this way ensures a high degree of replayability, which is advantageous from most, if not all, perspectives.

As a source of uncertainty in games, randomness provides one thing it is not normally credited for: a sense of drama. There is a moment of tension when the dice are rolled, or the player otherwise commits himself to a course of action the outcome

of which is luck dependent. When an underpowered character in a tabletop role-playing game succeeds in overcoming a fearsome foe by, say, rolling a critical hit, the player of the character is likely to experience a moment of fiero, of real triumph over adversity—in a way that would be impossible with a system lacking random elements.

Randomness thus has strengths: it adds drama, it breaks symmetry, it provides simulation value, and it can be used to foster strategy through statistical analysis. It has countervailing weaknesses: in excess, it imbalances games, it can foster a sense that success is a consequence of luck rather than excellent play, and it can produce frustration when a streak of bad luck affects a player. But given the ease with which it fosters uncertainty, it has a useful role to play in many games. As always, whether or not to harness randomness in a design is as much a matter of aesthetics as anything else; it has no place in a game of abstract strategy, but it is almost essential in a simulation.

Analytic Complexity

Reiner Knizia, one of the finest and most prolific designers of Eurogames, creates games that offer players only a handful of choices, but difficult ones. Similarly, Sid Meier, a designer of digital strategy games, says: "A game is a series of interesting choices." Though the games they create are very different, they're both talking about analytic complexity; they want games in which players need to think about what to do, have to parse a complicated decision tree, and perhaps are uncertain, even as they make a decision, that it is necessarily the correct decision to make.

This is, needless to say, a cerebral kind of game, and perhaps alien to those who play mainly digital action games. As such,

analytic complexity is not an appropriate source of uncertainty for all styles of games and all audiences. *Super Mario Bros.*, for instance, as fine a game as it is, does not involve any degree of analytic complexity, and there are those who, like Patrick Curry, consider it the ne plus ultra of game design.

I said previously that *Chess* is the game of analytic complexity par excellence, and so it is. However, this truth has limited applicability for designers or students of games. *Chess* is a game that has been iteratively refined over more than a millennium of play by many minds; it would take a genius of unparalleled talent to create so deep a game alone. Even so, occasionally a game like *Blokus* (Tavitian, 2000) appears that comes close. While trying to play in this arena is an interesting design challenge, we're mostly better off humbly accepting that a thousand years of folk refinement is always going to produce a deeper game than we can create in our mayfly lifetimes.

How, then, can we create games of analytic complexity? Brute force is one approach—creating a game with such complex rules that players find them hard to master completely. Many games do precisely this; Paradox, a Swedish developer of grand strategy games, does so routinely. Their best-known title is *Europa Universalis* (Anderssen, Berndal, et al., 2000) a game that spans the era from the fall of Constantinople to the rise of Napoleon, with systems governing economics, warfare, diplomacy, exploration, and colonization. At any given time, it is quite difficult, as a player, to determine whether your time and resources should best be spent on diplomacy with your neighbors, building up your military, improving your technology, or expanding colonially. And indeed, the optimal path is likely to change over the course of history; external events, such as a declaration of war, the emergence of a new power nearby, or one of the game's

many planned historical events, can throw a sudden monkey wrench into your plans.

Perhaps the most extreme example of brute force complexity is *The Campaign for North Africa* (Berg, 1979), a ludicrously detailed game of the North African front in World War II that does such things as track individual pilots and aircraft, with rules governing minutiae like water consumption (Italians consume more because they need to boil pasta, apparently) and the siting of prisoner of war camps (you may not place them in wadis because of the danger of flash floods). It typically takes 1,500 hours to play a complete game, the rules are 90 pages long and printed in 8-point type, and the amount of bookkeeping involved is staggering.[4]

In other words, simply layering on many systems and mechanics that interact with each other in complex ways makes it harder for players to grasp the system as a whole. This does, however, have obvious deleterious effects: so complex a system will ensure that the game appeals only to the small minority of players who are attracted to very complex games. And the very complexity of the system will also mean that it is hard for the designer to tune and balance.

Yet there are games that do this, and successfully: *Slaves to Armok: God of Blood, Chapter II: Dwarf Fortress* (Adams and Adams, 2002), more commonly known as *Dwarf Fortress*, is an example. The game simulates a fantasy world at a truly amazing level of depth, down to weather patterns and mineral deposits at arbitrary levels below the surface. It is largely an exploration and crafting game, in which you play a band of dwarves trying to build an underground civilization, mining for resources to expand and sometimes coming under attack by rival fantasy races. The developers have managed to keep the game in some

kind of balance by layering on new systems gradually; they're helped by an enthusiastic community of fans, who assist in tuning systems. This is, however, a rare and somewhat amazing accomplishment, particularly given that it is an indie game created by a two-man team.

Another approach to fostering analytic uncertainty is asymmetry. In a perfectly symmetrical game like *Hex* (Hein, 1942), all players strive for identical goals, with identical starting capabilities, and it is therefore typically straightforward to determine the degree to which an action benefits yourself and/or injures other players; the symmetrical nature of the game means that, all things being equal, players' analytical paths tend to follow the same line. The moment a degree of asymmetry is introduced, players come to value the actions available to them differently, and analyzing play requires them to try to understand what and why the other players are doing what they are doing.

An example of this in action is *Medici* (Knizia, 1995). Players are Renaissance merchants, bidding on lots of commodities. Each commodity marker is printed with a numerical value and is of a particular type—leather, silk, spices, and so on. Each round of the game, you may purchase up to five items, and at the end of the round, players score the printed commodity values, with bonuses for those with the highest total value. So far, this is perfectly symmetrical; a commodity with a value of five is worth five to every player.

However, at the end of each round, each player records how many units of each type of commodity they shipped; for this purpose, leather with a value of zero still counts as a unit of leather, and so does leather with a value of five. At the end of the game, players score additional victory points if they shipped the most of a particular commodity during play. Thus if, say, I shipped

three units of leather in the first round, I have a strong incentive to ship more units of leather; leather is now worth more to me than it is to another player, and I must ponder whether a commodity's type or numerical value is more important to me at any particular juncture—and also whether it is worthwhile to prevent one of my opponents from getting a commodity that, while not inherently all that valuable to me, is sufficiently valuable to them that it can push them into the lead.

Medici is, in rules terms, quite a simple game, on the low end of the Eurogame scale; but the way in which it breaks symmetry produces considerable analytical uncertainty.

Digital games do this less than nondigital ones, but some do purposefully break symmetry in similar ways; *StarCraft* (Phinney and Metzen, 1998) has three different races (Terrans, Zerg, and Protoss), each with different units and different capabilities. In a multiplayer game, you have to plan optimally for your own race but also consider what actions others are likely to take on the basis of the capabilities they possess. This makes it a much deeper game, from a strategic point of view, than *WarCraft: Orcs and Humans* (uncredited, 1994), its precursor; in that game, the different races had the same capabilities, with racial differences affecting only appearance—mere window dressing, in other words.

In general, analytic complexity is the product of a system that allows a player several options but forces trade-offs. In *Chess*, you may make only one move each turn, and therefore must ponder which of the options available to you is best. In an action selection game such as *Puerto Rico* or *Agricola* (Rosenberg, 2007), you have a choice of actions each turn, but may select only one, and must determine which is best for you and which is suboptimal for others. In *Civilization*, a city may construct only one

thing at a time, so when selecting what to build next, you need to consider whether making your population happier, larger, or more productive is most essential at present—and whether it would be advantageous to forego these options in order to create a Wonder of the World. These games are very different from each other, but all require the player to contemplate trade-offs.

Analytic uncertainty inherently produces a cerebral style of play, which is both its advantage and its weakness. Many gamers do not particularly want mental challenges from the games they play. Hard-core videogamers typically prize spectacle and the mastery of the physical skills needed to beat opponents and bosses; they're accustomed to the kind of uncertainty that depends on player skill. While they will tolerate some degree of puzzle solving, they want to be swept up in the moment of play, to be, for the most part, in a flow state, and not be halted to think deeply about the next thing they must accomplish. Similarly, casual gamers prize lean back games that allow them to while away some time in an interesting way, with a degree of visual spectacle and a continuing dopamine drip of nicely timed rewards; they don't mind a modest cerebral challenge, such as recognizing potential match-threes, but they're playing to relax, and a deeper mental challenge is not what they're after.

Another issue is that analytic uncertainty often leads to analysis paralysis, the phenomenon whereby one player agonizes over his choices and delays the game for others. And of course, action games can support only modest levels of analytical complexity, because, by nature, a game that requires quick responses by players cannot also pose difficult mental challenges for them.

Yet games of this style do have their devoted partisans; as with all things, whether or not to make analytic uncertainty central to a design depends on your objectives and ambitions.

Hidden Information

Hidden information is a source of uncertainty in a wide variety of games. In many games, its main role is to foster a desire for exploration; in *Sid Meier's Civilization*, known simply as *Civilization*, you can see only the area immediately around your two units at the start of the game, and the vast remainder of the world is dark. There's a thrilling sense of a world to explore. Similarly, most modern videogames are 3D environments that you explore, controlling a single character; much of the enjoyment of the game comes from finding out what amazing sights and challenges the developers have scattered about their world. Contrast this with boardgames, in which the extent of the system is known and visible before play.

Donald Rumsfeld famously spoke of "known unknowns and unknown unknowns." In these kinds of games, the world is an unknown unknown; you know certain things about it, such as the theme and fantasy of the game you are playing, but the rest is to be discovered. In many other game styles, however, hidden information is a form of "known unknown"; in a game of *Poker*, you may not know what cards the other players hold, but you know the range of possibility. A player will not surprise you by playing the thirteen of hearts, for there is no such card in the deck.

Hidden information of this kind is common in board and card games; indeed, the primary use of cards is to allow players to have information hidden from others. These known unknowns create strategic concerns for the players; in *Poker*, you are always trying to divine what cards your opponents may hold. The uncertainty is partial, because some information is revealed—the "up cards"—but in many other games, players do not have even that

much information. In *Memoir '44*, for instance, there are no up cards to give you a hint as to your opponent's cards; since you are ignorant of them, you must try to plan for all possible eventualities, which increases the bushiness of the decision tree.

The same kind of phenomenon is seen in multiplayer digital games as well. Real-time strategy games such as *StarCraft* have "fog of war" systems, meaning that areas of the game world distant from your units are not visible to you. This increases uncertainty to a tension-inducing level; in the early stages of a multiplayer RTS game, you know that your opponents are working feverishly to build up their base and military strength, but can't see how they are progressing, which motivates you to work even more feverishly; and when battle is joined, you may be surprised by an enemy attack before you are ready, or conversely launch an attack on an enemy to find that he has already been laid to waste by a third player.

Hidden information often fosters experimentation. In a text adventure, you experiment with different formulations of words, testing the limits of the text parser (and the designer's cleverness at anticipating things players may want to say). In many games with crafting systems, such as *Harvest Moon: Tree of Tranquility* (Ishikawa, 2008), you are not provided recipes and instead must discover what you can craft by experimentally combining different resources (or Googling for a guide, of course). In *NetHack*, you may know what range of potions exists in the game, but you don't know what a "plaid" potion does until you experiment with it. In a sense, this is exploration—but of the parameters of the system rather than of physical space.

In general, hidden information increases variety of encounter; in a game with a designed world, everything is a surprise when first encountered; in a game with algorithmically generated

challenges (such as *Poker* or a Rogue-like), hidden information ensures that no two sessions are the same.

The potential flaw of hidden information is that, as with randomness, players may feel that what they encounter is arbitrary, or be unable to make reasonable decisions because they lack enough information to do so intelligently. In *Minesweeper* (Donner and Johnson, 1990), your initial click is purely arbitrary and may result in a loss no matter how clever you are, and indeed it may not be for several clicks before you have enough information to play effectively—a flaw of the game, redressed by the fact that you have invested little time at this stage, so restarting is not onerous.

Hidden information is such a powerful source of uncertainty that simply adding an element of it can transform an otherwise flat design into one that is quite compelling. *Agricola* is a good example; it is a game of perfect information and symmetrical strategy except for the cards that are passed to the players at the inception of play, which offer each of them advantages and opportunities different from the others, and are not revealed until used in play. The rules provide for a "family" version of the game that excludes these cards (which add considerable complexity), but the family version—while useful in introducing new players to the game—is quite dull. The cards make *Agricola* a far more interesting game.

Narrative Anticipation

Stories, like games, require a degree of uncertainty. What keeps us reading a novel is a desire to see what comes next. In general, if what comes next is wholly predictable, we will think the novel dull. Even in genres where overall story arcs are predictable—in a romance, you know that the female lead will find love, and it's rare for there to be much uncertainty about with whom

after the first chapter or two—there is still great uncertainty on a moment-to-moment basis, and the twists and turns and surprises of the story keep us interested.

Much the same is true when it comes to games. It is true, most obviously, of games with strong story elements, like graphic adventures and modern action-adventure games like *Elder Scrolls V: Skyrim* (Nesmith, 2011); but it's true of other game styles as well. It's true of games with a quest structure, such as *World of Warcraft* or *CityVille*, where the story moments are discrete and finished over the course of a small quest chain, rather than over the game as a whole. It's true of platformers, in which the narrative may be very slight—defeat all the castles to rescue the princess—but in which we anticipate that each new level will have new and interesting challenges, as well as a new visual appearance, and look forward to that experience.

And it's even true of games as abstract as *Chess*; playing, we want to see how our opponent will react, how forces will ebb and flow over the course of play. There's a sort of narrative arc at work here, even if there is no direct connection to story.

In terms of narrative, anticipation is the key; this means keeping the player uncertain as to how the story, or play arc, of the game will evolve. Many games fail on this score, at least after a time; *Chess* is an example. At some point, it is fairly obvious who is going to win a *Chess* game; the endgame is dull. The game does not conform to the classic narrative arc of increasing tension followed by release. Rather, tension builds to a point, and then slowly declines, as the board is cleared and the stronger player emerges, with a whimper of a coda as, often, the king is chased about the board until the inevitable checkmate.

In general, games that have positive reinforcement cycles, in which success begets greater strength, suffer from endgames

lacking narrative tension. In *Risk* (Lamorisse, 1957), for instance, a player who quickly gains, and is able to defend, control of two continents is in a very strong position *vis-à-vis* his opponents—a problem that classic *Risk* counterbalances with its card system. Even a player in a weak position can cash in a trio of cards for a large number of additional armies—which may not be sufficient to outweigh another player's growth over time through control of continents, but which does give the player the opportunity to take many areas and alter the shape of the game for a time. Consequently, you can never count a player out until his last army is destroyed. This is, in fact, why *Risk: Factions* (uncredited, 2012), the social variant of the game, is less satisfying; absent this card system, weaker powers decay and stronger powers grow, and the endgame is predictable and dull.

One way of addressing the problem is by incorporating negative reinforcement loops, whereby strength is redressed in other ways. In *Kingsburg* (Chiarvesio and Iennaco, 2007), for instance, the first mover in each turn has a strong advantage, and the game determines player order in inverse power order. Thus, the weakest player gains an advantage that may help him to overcome the stronger ones.

Another is by ensuring that even very weak players still have some chance of affecting the outcome, or even of victory; in *Diplomacy*, a player reduced to a single supply center may still participate in a draw, if his last remaining unit is critical in the formation of a stalemate line.

Similarly, many digital games have some system of dynamic difficulty adjustment to ensure that even a strong player remains challenged by the system; many racing games, for instance, speed up NPC vehicles if the player is performing very well and slow them down if the player is performing poorly. The objective

isn't to reward failure or penalize success, but to sustain narrative tension by ensuring that the player always feels challenged.

In general, designers should always work to shape a game's play arc into a pleasing experience; it is helpful to think of this by direct analogy to the narrative arc. You want to hook players quickly, without exposing them to too much detail and complexity at the start, ramp up tension over time, and sustain tension into the endgame.

Whether to incorporate an explicit narrative is, however, a more difficult issue. Most videogame players expect their games to deliver story, but there are many successful game styles that do not: arcade games, real-time strategy (RTS) and FPS games in multiplayer mode, and many (though not all) casual games. In general, incorporating story has strong advantages, in terms of player engagement and narrative anticipation, but also countervailing problems. In particular, games require a degree of player agency but stories require a degree of linearity, and these two factors are in direct conflict.[5]

The use of story in games neverending—games like massively multiplayer online (MMOs) and social games, which never come to an explicit end—is particularly problematic. Stories, by nature, have arcs and reach conclusions; games neverending cannot.

Some games, such as *Asheron's Call* (Ragaini, 1999), have tried to impose a narrative arc, with the world changing and the story advancing each month; players, however, don't typically feel involved in these stories and simply view updates as the introduction of new monsters to slay, areas to explore, and so on—new content, but not in a meaningful narrative sense.

Most games neverending try to incorporate a sense of narrative with the use of quests or missions, and these can be viewed as small narrative loops embedded in a larger game system;

players tend to tune out the narrative elements in these missions, however, simply scanning to find out what they need to do to complete it and receive the offered reward; take box X to location Y, thanks, never mind the hugger mugger about the evil orcs. Unless you're telling me that I need to prepare to kill some orcs along the way.

Surprisingly, social games, in particular, have not experimented with stories that *do* reach a conclusion; a social game player typically sticks with the game for a mere handful of months before drifting away. In principle, there's no reason you can't design a game to last for, say, six months; such a game might well retain its players longer than ones that are open-ended. And while some players would doubtless take the end of one game to mean that it's time to move on, those who enjoyed it most might well sign up for a second play-through. This would be harder to accomplish with MMOs, which involve a more intense time commitment, but, notably, one indie MMO does precisely this; *A Tale in the Desert* (Tepper, 2003) runs for a year and change, ends in a definitive conclusion, and restarts—with Pharoah (Andrew Tepper, its creator) making changes to the game with each new play-through.

Sustaining narrative tension is an issue with games of all sorts; the use of a literal narrative is essential for some kinds of games, of benefit to others, and irrelevant to many others.

Development Anticipation

Until the rise of online gaming, games were largely fixed on release. That is, the game itself was a single, unchanging entity, fixed in a tangible medium, whether a set of components in a box or data on a cart or disc. This is no longer true; it is

obviously untrue of games that live largely online, such as social games and MMOs, but untrue even of more conventional titles, which are often patched over the network after release and, increasingly, for which developers create postrelease content, sometimes offered for free and sometimes as paid downloadable additions.

Some gamers decry this, feeling that they ought to get "the full game" when they plunk down their money; but for games neverending, at least, it's actually a draw for the players. Conventional digital games are usually designed for a one-time playthrough, like a novel or film; games never-ending also have content that a player consumes over time, but since the game is expected to go on ad infinitum, when a player comes to the end of the available content, rather than placing the game on a shelf, he pesters the developers for more.

Back in the 1980s, I did some work for Prodigy, a commercial online subscription service that predated the Internet.[6] Prodigy conducted a survey of its subscribers to determine what kept them coming back to the service: Shopping? News? Games? The number one reason subscribers gave was the desire to see how the service evolved.

They were, of course, early adopters of a then new technology, so the answer is not all that surprising. But the same element is true for many digital games today. Players of *CityVille* are delighted when new features and buildings are released. Players of *World of Warcraft* retain their subscriptions even when they've hit the level cap, knowing that Blizzard will release a new expansion at some future time. And indie developers are increasingly selling their games even while in beta, often long before they are complete, at a lower price, getting players excited about the game and harnessing their input to polish and improve it over

the course of development; *Minecraft* (Persson, 2010) sold more than four million units before leaving beta.[7]

Schedule Uncertainty

Social games are typically designed for short play sessions but engagement over months or years. In part, this dynamic is historical; social games evolved from earlier web games that were offered for free (supported by ads). In order to minimize costs—reducing server loads and bandwidth usage by players—these games limited the amount of time a player could spend in a single session with energy limits or similar mechanics. Social games simply borrowed these mechanics, even though their per-customer revenues are far higher, and both server and bandwidth costs have declined over time.

In part, however, the mechanic is also designed to cater to the largely casual audience for social games; older casual-downloadable games were also designed for short play times—a few minutes for a complete but replayable game—because casual players do not want the lengthy, multihour experiences of more hardcore games.

The main reason the mechanic persists, however, is that it reengages players. At the end of a session, players typically have more things they wish to accomplish than their available resources permit; they are encouraged to return later, when their energy recharges, their crops grow, or whatever. In social games, this is called a "timed reengagement mechanic," its purpose to induce players to return (and, hopefully, monetize; they can always buy their way out of these limits).

To my mind, this is a crude and fairly unaesthetic form of uncertainty—the uncertainty caused by your own erratic

schedule; gating gameplay in this way strikes me as often frustrating. Yet it is a proven financial success for social game developers, and money does, alas, trump aesthetics.

Uncertainty of Perception

The last type of uncertainty we discussed is uncertainty of perception, the difficulty of perceiving what's going on in the game space. The classic example is the hidden object game, which requires a player to visually identify items on the screen, but other games harness this same issue to some degree. In a bullet-hell shmup such as *Geometry Wars: Retro Evolved* (Cakebread, 2005), the screen is typically so busy that a major part of the game's challenge is parsing the view, focusing on the visuals representing bullets or enemies while screening out all the visual noise of the screen. In *Tetris*, the challenge is to recognize the shape of the new dropping piece quickly, and scan those already at screen bottom, finding the optimal placement for your piece, in whatever rotational state, as quickly as possible; there's a puzzle-solving aspect to this, in addition to a skill-and-action component, but the need to perceive quickly plays a role as well.

And in rhythm games such as *Guitar Hero* (Kay, 2005), much of the player's uncertainty lies in perception: in listening attentively to the rhythm of the music, watching carefully advancing notes along the visual musical path, and timing fret-button presses to match. That is, there is a skill-and-action component—mastering color-coordinated button presses—but also a matching perceptual challenge—knowing precisely when to trigger a button press or chord.

In general, designers rarely think about the tuning of perceptual challenges, but perhaps they should; one way to make any

game more difficult, after all, is to make it harder for the player to perceive precisely what action they must take at any given time.

Malaby's Semiotic Contingency

Malaby describes semiotic contingency as "the unpredictability of meaning that always accompanies attempts to interpret the game's outcomes."[8] He gives as an example his experience learning to play *Backgammon* in Greece; Greeks consider it something of a national game, and as his game improved, his opponents would say things like "You're a Greek now." In other words, they were ascribing a cultural meaning to the game external to the game itself.

At first thought, one might say that semiotic uncertainty, which is external to the formal structure of the game, is not relevant to our exploration of uncertainty in games; it's not a source of moment-to-moment uncertainty in play.

But on reflection, there *are* games, albeit not many, that consciously work to create cultural meaning, and in some cases, the ways in which they do so do contribute to a form of uncertainty. One example is *Train* (Brathwaite, 2009). *Train* is an art boardgame in which players load little yellow "meeples" into rail boxcars, then move the trains about a track. Only when a train reaches its destination is the nature of that destination revealed; all are named for Nazi extermination camps, and by implication, you are delivering Jews to their deaths. This epiphany totally changes the meaning of the game for the players, creating a real and unsettling emotional impact.

Or as a less arty example, *Syobon Action* (z_gundam_tenosii, 2007) is a masocore platformer that uses the tropes of *Super*

Mario Bros. to play with the player's head. For example, when you reach the end of a level, there is a flagpole; in *Super Mario Bros.*, there are likewise flagpoles at the end of each level and, in that game, you must leap on the flagpole to free someone imprisoned in the nearby castle. In *Syobon*, when you leap on a flagpole, the flagpole kills you.

This is a form of ludic self-referentiality, of course; it's a game commenting on a game, but it's the cultural meaning of *Mario*'s tropes that make *Syobon* interesting (and infuriating, and hilarious) to experienced platformer players. In this context, we're talking about game culture rather than national culture, but that doesn't change the fact that this is a form of semiotic uncertainty. Once you've jumped on a flagpole, you question the meaning of everything else you encounter in the game, rightfully, and are uncertain what the consequences of an action might be.

Semiotic uncertainty is not a characteristic of many designed games, but as these examples show, it can be effective, and perhaps designers should consider how to foster it more often in their work.

6 Game Design Considerations

Most game design is imitative; that is, a designer typically looks to existing, successful games, adopts proven mechanics, and alters mainly theme, setting, and story (if any). Innovation tends to be incremental, the designer seeking to improve or add a new aspect to existing mechanics. In part, this is because of the conservatism of publishers, who (mostly wrongly) believe they are minimizing financial risk by minimizing design risk; in part, it is because few designers have the confidence and desire to innovate in more fundamental ways.

Thus, most designers, most of the time, do not think about where uncertainty lies in their games; they are working within a well-known genre, and the mechanics they adopt have already been shown to produce results that please players. The uncertainties the genre creates are already tuned.

From time to time, however, a designer is faced with a challenge that can't be met simply by stealing systems from another game: an unusual topic, a different demographic, a novel technology, a goal other than entertainment. And at times, even when adopting well-known systems, modest changes to mechanics can make a game feel flat, for reasons that may not be immediately evident.

In cases like these, it is helpful to take a careful look at the game and identify where its uncertainty lies. What uncertainties does the player face? Are they sufficient to make the game challenging, at a level of challenge that is appropriate for the audience? Are they the kinds of uncertainties that are likely to appeal to the game's intended audience? And perhaps most important, would the game be strengthened by introducing a different form of uncertainty, or reducing or eliminating an existing form?

Lack of Uncertainty

Just as writers sometimes dream stories, I sometimes dream games. One night, I dreamed of a Eurostyle game in which night elves and humans both grew crops and stored them in Persephone's granary, drawing on the granary in times of need, the elves working at night and the humans in the day, in a both competitive and cooperative fashion. As an experiment, I put together a playable copy of *Night Grain*.[1] It turns out that my subconscious is not a very good game designer. *Night Grain's* fatal flaw is that it is a game of perfect information and symmetrical positions. The result is that players adopt identical strategies, the correct move is almost always blindingly obvious, and it is, in a word, dull.

How could it be improved? Evidently, it needs a greater source of uncertainty. Hidden information of one kind or another is an obvious approach; a random element is another. Of course, since it is intended to be a Eurostyle game, any random element would have to alter the opportunities for all players rather than make the outcome luck-dependent, in the fashion of *Medici* (where commodities are drawn from a bag but all have a chance to bid

on them) rather than in the fashion of *Risk*. Another approach would be to introduce a stronger element of player uncertainty, allowing players to more directly affect each other; or of analytic uncertainty, complexifying the simple track system of the current game.

As another example, *Deep Realms* (uncredited, 2011) was a game that attempted to bring the dynamics of Japanese-style RPGs to Facebook. Japanese RPGs are characterized by strong stories and characters, married to complicated but turn-based combat systems. Their main sources of uncertainty are in the narrative—the desire to unlock the next element of the story is a major draw for players—and a degree of analytic complexity in the combat system, which is not deep but does require different tactics against different opponents.

Deep Realms copied the basic combat dynamics of the genre but simplified them somewhat, with the idea that social games appeal to a more casual audience than console titles; and while it had a sort of story, it was somewhat perfunctory, and not nearly as well-written as, say, the story of *Final Fantasy X*. And, to be sure, *Deep Realms* had nothing like the gorgeously rendered cinematics of that game.

In short, the uncertainties it posed to players were far weaker than those of the genre it was copying; and it suffered from the main flaw of the genre (boring and repetitive combat between story moments). Unsurprisingly, it was not commercially successful (and has been shut down by the developers).

In both games, the uncertainties pose no real challenge to players, and, in both cases, the game would be improved either by strengthening existing sources of uncertainty, or introducing new ones.

Excessive Uncertainty

Excessive uncertainty is equally often a problem. Warning signs of excessive uncertainty include players unable to figure out what to do; games whose path and outcome seem out of control and unrelated to player actions; and “analysis paralysis,” the phenomenon of games delayed by lengthy player pondering.

One example is Disney *Epic Mickey* (Jones, 2010). It is a 3D platformer in which, as is typical in such games, the camera’s position is usually controlled by the game itself as you navigate the gameworld. While *Epic Mickey* allows you to alter the position of the camera with the controller’s D-pad, the camera moves quite slowly when you do. And, of course, as in most platformers, quick timing and response is necessary to navigate obstacles and defeat enemies. The problem is that the camera’s motions are quite unpredictable from a player’s perspective, and the game will often move the camera in a way that makes it difficult to avoid dying—in mid-jump, for instance. In other words, the camera functions in a way that players find highly uncertain, making for a frustratingly difficult game. Positively reviewed in most other regards, the game was consistently dinged for poor camera control.

The fix here would obviously be to polish the controls more highly: to make them behave consistently and, ideally, almost invisibly to the player, removing this source of uncertainty.

Another example, in a very different way, is *Crusader Kings* (Bergqwist, 2004), particularly its treatment of marriage. You control a noble house over many centuries of the Middle Ages, and the game tracks hundreds of noblemen and women across Europe and the Middle East. Each character has widely divergent characteristics, and success in the game is critically dependent on finding a good mate for your monarch—that is, one with

positive traits that will be passed onto your heir, so that your monarch is always an effective governor and warrior. When I say “critically dependent,” I mean this literally; at one point, I had an insane, wife-killing, incompetent and despised monarch, and watched as my vassals broke away, neighbors declared war, and my entire realm fell apart.

The difficulty is that finding the stats of a potential mate requires you to examine the court of their noble house and pore over the statistics displayed. Given the hundreds of characters tracked by the game, this becomes tedious and irritating; typically, you settle for good enough, with unpredictable effects on the game’s path. The uncertainty here is irritatingly high. Not surprisingly, fans of the game produced a little application that scans the game’s data and provides a nicely sorted list for you, showing available mates and their data.

This, unfortunately, reduces the uncertainty of the system perhaps too much; armed with the data, finding a good mate becomes easy in most circumstances, and success in the game becomes virtually assured. The optimal balance for the game is probably somewhere between its original design and the fanware addition: easier access to information than the game provides by default, but not the perfect information provided by the fanware.

Unsurprisingly, *Crusader Kings II* (Fåhraeus and King, 2012) recently released, does precisely this—providing some but not perfect information in a nicely formatted way.

Combining Sources of Uncertainty

Typically, when designers think about tuning gameplay, they think about tuning the difficulty of existing systems. In

a platformer, if the game seems too easy, you make the time window for player response narrower; if it seems too hard, you expand the time window or work to make the controls crisper and more responsive. In a Eurogame, if player choices seem too obvious, you might layer on another system to increase the analytic complexity; if analysis paralysis is a consistent issue, you might seek to simplify one or more mechanics, to tune the analytic complexity lower.

What designers rarely do is introduce a new and different form of uncertainty, because this is not an immediately obvious way to handle the problem. And yet, doing this can be quite powerful and lead to highly original work.

One example is *Spelunky* (Yu, 2009). At first glance, it appears to be merely a platformer, a long-standing and well-understood game style, well executed for its type but far from original. Almost immediately, however, it becomes apparent that this game is extraordinarily original and quite different from any platformer that came before. Conventional platformers, like *Super Mario Bros.*, have a set of unchanging levels, played in an unchanging sequence, each level laid out by a designer. *Spelunky*, like *NetHack*, creates its levels algorithmically, so that no two play sessions are ever identical. In other words, Yu took a game of pure performative uncertainty, added a strong element of randomness, and produced an extremely novel and fascinating game—with, to be sure, some of the problems to which Rogue-likes are prone, including highly variable difficulty depending on luck.

Another example, *Portal*[2] (uncredited, 2008) is, in a sense, a first-person shooter, in that the player navigates a 3D space from a first-person viewpoint and interacts with the world primarily by firing a gun. However, the gun is used to create portals between two separate locations in the gameworld and, for

example, stepping into a portal on the floor causes you to "fall" out the other end of the portal, which may be flat against a wall, giving you a trajectory that may allow you to get to an otherwise unreachable space. It is, in fact, a puzzle game, in which traversing each level requires use of the portal gun in clever ways. To put it another way, *Portal* turns a game style that is normally dependent primarily on performative uncertainty into a game of solver's uncertainty.

And as a third example, the core mechanic in *Triple Town* (Cook, 2010) is "match three," a somewhat tired scheme used by a huge number of casual games. *Triple Town* is played on 6 × 6 grid. Each turn, the game feeds you an item; place three in a row, and they turn into a more valuable item at the third-placed location. There's some variability, in that what item you are served each turn is randomly determined, but you may "park" one item and pick it up later if you like.

If this is all there were to the game, it would be dull; the best strategy for maximizing your score is easily determined: Avoid blocking off areas of the grid when you match three, so that you can close-pack the grid with maximally scoring items. The only real variation in path would result from the random generation of items.

But there is a second element: Sometimes you are served a bear, which you must place. Bears do not "match-three"; instead, they move at random within the grid. Once bears are in play, your ability to place objects is constrained, in an unpredictable way; the location where you want to place may be occupied by a bear this turn, and since their movement is random, you can neither control nor predict their behavior. If a bear cannot move, that is, when you block one or a group of bears off by placing items so that there are no free squares in their vicinity,

the bear turns into a tombstone; and tombstones can be match-three'd, becoming more valuable churches.

In short, without bears, *Triple Town* would be a cut-and-dried, fairly dull game; but the addition of an element of random uncertainty transforms it into a far more engaging (and sometimes frustrating) game.

Combining different sources of uncertainty, or injecting a novel source of uncertainty into an otherwise well-understood genre, can create highly original games and should be one of the tools in any intelligent designer's toolbox.

7 Conclusion

Games are uncertain, and must be so to remain interesting; but sources of uncertainty are manifold. This book has discussed many such sources—as many as I could think of—but I do not wish to claim that others are impossible. Nor should you assume that uncertainty is the only important aspect of games, and that by understanding where uncertainty lies in a game, you understand it in an essential way, any more than, say, by understanding the role of plot in a novel, you understand everything worth understanding about it: subtext, the use of language, and the ways in which character is expressed are all of equal importance. Just so with games: mechanics, sensory expression, interplayer dynamics, and play patterns are at least as important in shaping the player experience as uncertainty. Understanding uncertainty is helpful; but this book is by no means intended to be a complete and hermetic guide to understanding the ways in which games create meaning, and all you need to master the difficult and fluid craft of game design. Just as there are almost as many ways to write as there are writers, and no single formula to creating successful prose, there are almost as many ways to design games as there are game creators, and there is always something new to be learned with each game played.

It is my hope and desire that the discussion here will be enlightening and perhaps useful, but it will be more useful to read—and play—widely.

So get out and play.

Notes

2 Games and Culture

1. Carel P. von Schaik et al., “Orangutan Cultures and the Evolution of Material Culture,” *Science* 299, no. 5603 (2003): 102–105.

3 Uncertainty

1. Caillois, Roger, *Les jeux et les hommes* (Paris: Librarie Gallimard, 1958), pub. in English as *Man, Play, and Games,* trans. by Meyer Barash (Glencoe, IL: The Free Press of Glencoe, 1961).

2. Katie Salen and Eric Zimmerman, *Rules of Play: Game Design Fundamentals* (Cambridge, MA: MIT Press, 2003).

3. Thomas Malaby, “Beyond Play: A New Approach to Games,” *Games and Culture* 2, no. 2 (2007): 95–113.

4 Analyzing Games

1. How they succeed or fail as games qua games, I mean; my interest is in their aesthetic merits, not their commercial ones.

2. Patrick Curry, “Everything I Know about Game Design I Learned from Super Mario Bros.,” *Well Played 1.0: Videogames, Value, and Meaning*, ed. Drew Davidson (Pittsburgh, PA: ETC Press, 2009), 13.

3. Chris Crawford, *The Art of Computer Game Design: Reflections of a Master Game Designer* (Berkeley, CA: McGraw Hill/Osborne Media, 1984).

4. Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimal Experience* (New York: Harper & Row, 1990).

5. Per private discussion with Romero.

6. Salen and Zimmerman, *Rules of Play*.

7. Russia's apparent advantage—four starting units—is more than redressed by a strategic disadvantage: its provinces are large, each adjacent to many smaller provinces, meaning that opponents can more easily mount an attack, with multiple supports, on Russia's home areas. In truth, England and Turkey are the most powerful positions, since they are at board corners and cannot easily be attacked from the rear.

8. This is also why the study of boardgames is useful for students of game design; the systems of a tabletop game are directly perceivable, whereas it's often hard to figure out what a digital game is doing and why.

9. Alas, it is far from the most interesting variety and is popular solely because it is more easily televisable than other versions of the game.

10. Greg Costikyan, "Randomness: Blight or Bane," a presentation at GDC Austin 2009, available at http://playthisthing.com/randomness-blight-or-bane.

5 Sources of Uncertainty

1. "Ameritrash" is a back-formation from "Eurogame" and typically refers to games that are (a) more chance dependent, (b) involve direct conflict among the players, and (c) have longer play times than Eurogames.

2. Stewart Culin, *24th Annual Report of the Bureau of American Ethnology: Games of North American Indians* (Washington, DC: US Government Printing Office, 1907).

3. David Parlett, *The Oxford History of Board Games* (Oxford: Oxford University Press, 1999).

4. When it was being playtested at the Simulations Publications Inc. (SPI) offices, the necessary forms needed to track the game's data were kept in manila envelopes thumbtacked to the walls of the playtest room. Some wag added another envelope containing the "Form Requisition Form." This should indicate the complexity of the system—as well as, of course, why so complex a system was not necessarily a good idea, however much it may replicate the system of a bureaucracy at war.

5. I've written about this issue in "Games, Storytelling, and Breaking the String" in *Second Person: Role-Playing and Story in Games and Playable Media*, ed. Pat Harrigan and Noah Wardrip-Fruin, 5–13 (Cambridge, MA: MIT Press, 2007).

6. More properly, the Internet existed at the time but was restricted to academic and government use, so normal people who wanted access to online services had to subscribe to one of the COLS—Prodigy, AOL, CompuServe, and so on.

7. http://www.1up.com/news/minecraft-sales-exceed-4-million.

8. Thomas Malaby, "Beyond Play: A New Approach to Games," *Games and Culture* 2, no. 2 (2007): 95–103.

6 Game Design Considerations

1. You can find a print-and-play version at http://playthisthing.com/night-grain, but it is pretty bad.

2. The game's credits simply list all developers, without ascribing design to any individual or group.

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